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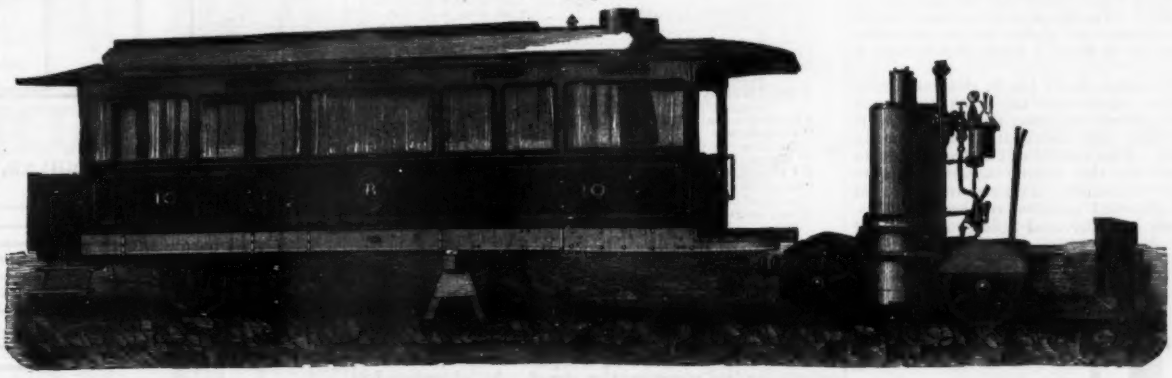
STEAM CARRIAGES.

At the Antwerp tramway trials, the Rowan steam carriage was awarded the gold medal in the first competition of Group I.—locomotives or automotive vehicles for towns and cities. In seeking a method of working tramways and light railways economically, Mr. Rowan adopted the principle of reducing the dead weight by the use of an engine whose power considerably exceeds its adhesion, while utilizing the weight of the passengers for the balance of adhesion; and this he accomplishes by supporting the vehicle on two bogies, one of which is the motor. Fig. 1 of the accompanying illustrations shows the manner in which this principle is carried out. The body of the carriage may be raised by a pair of screw jacks, and the front bogie carrying the engine and boiler run out, thus rendering it perfectly accessible for cleaning, inspection, and repairs. This operation, which is common to all three types of these carriages, viz., for town tramways, light or secondary lines, and railways, is accomplished most easily and rapidly, eleven minutes being sufficient to run the engine out and in again.

Fig. 2 shows the steam carriage which took part in the Antwerp competition, and Fig. 3 a plan thereof one-fiftieth actual size. Although the middle is shown open for summer traffic, it may be completely closed for the winter, and also warmed by the exhaust steam without extra expense. The total length is 9½ meters, or 31 ft., and that of the body 8·15 meters, or 26 ft. 9 in., while the width of latter is 2·2 meters, or 7 ft. 2 in. The wheel base is 22 ft. 6 in.; and the car, of normal gauge, is capable of running round curves of 15 meters, or 16½ yards, radius. The total weight in running order is 7½ tons; and the maximum weight of the wheels on the rails with full load 1·7 tons, the weight available for adhesion in this state being 6·2 tons. The steam carriage as shown will carry 50 passengers, and 110 when drawing a supplementary car after it. One man is sufficient to stoke, drive, and brake, so that, with the conductor for tickets, only two men are required for working. The tractive power is 500 kilogrammes, or 25 horse-power, sufficient to mount gradients of 1 in 20; and on the level a speed of 20 kilometers, or about 12½ miles, an hour is attainable. When running at half that speed, with dry rails, the carriage may be pulled up in 10 meters. The car was made by Herbrandt, of Ehrenfeldt, near Cologne; and the engine by Borsig, of Berlin.

The engine shown run out in Fig. 1 is of an early type, with inverted cylinders; Fig. 4 illustrates the engine of a larger form of steam carriage for light railways; and Figs. 5, 6, and 7 give details with metrical dimensions. But, as shown at Fig. 3, the boiler for the

FIG. 1.



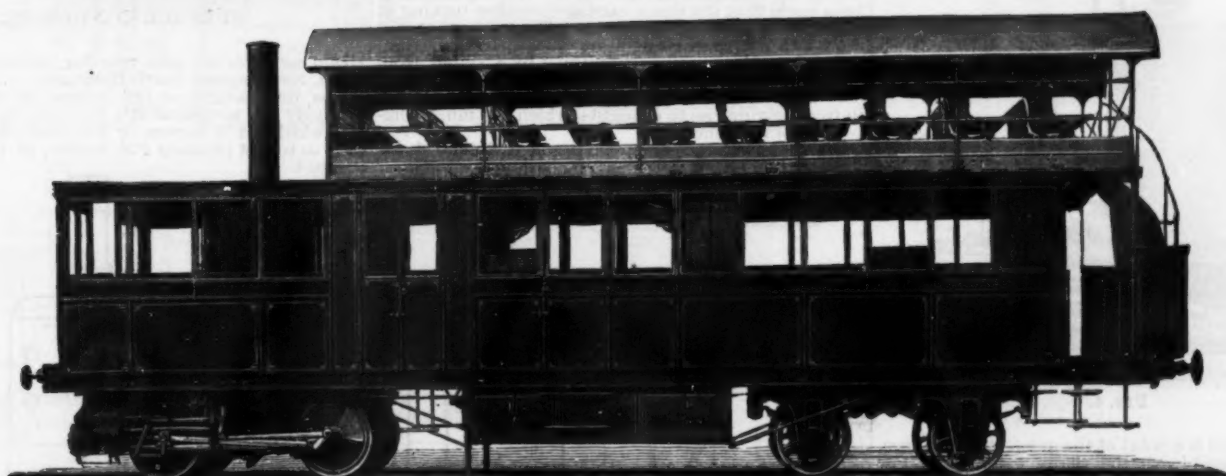


FIG. 3.

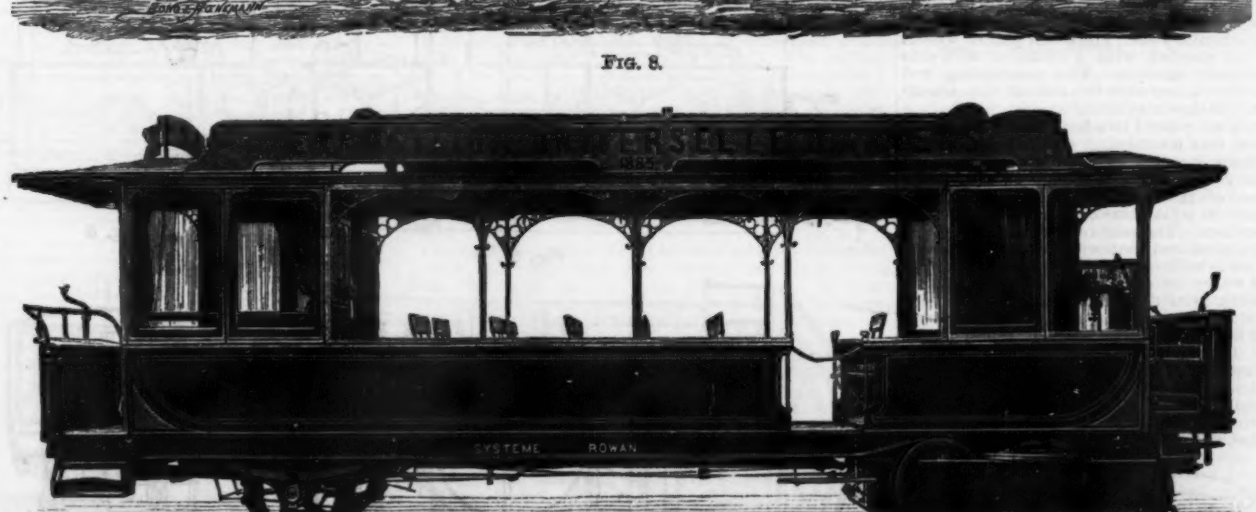


FIG. 2.

STEAM CARRIAGE TRIALS AT ANTWERP EXHIBITION.

town steam carriage is made double, in accordance with the sketch above, with two internal fire-boxes and two chimneys with natural draught, the horizontal member considerably strengthening the vertical shells of 0·54 m. = 21¼ in. diameter, containing cross water tubes. This arrangement provides a large steam space, and affords plenty of dry steam, which can be raised in thirty-five minutes, 400 kilogrammes, or 881 lb., of water being evaporated per hour under a pressure of thirteen atmospheres, or 195 lb., per square inch. The boiler is so constructed that, by unbolting a flange and lifting off a plate, the tubes with turned flanges are freely exposed, so that the inside may readily be cleaned; but, thanks to the active circulation, no scale has yet been formed. There is no coke bunker, but the fuel is contained in sheet iron boxes, containing about 4½ lb., and hooked on to the hand-rail, so that the fire is fed without shovel and with the greatest ease and cleanliness. At Antwerp 100 kilogrammes, or 2 cwt., of gas coke were burnt every day for the run of 80 kilometers, or nearly 50 miles, which amounts to 1¼ kilogrammes per kilometer, or about 4½ lb. per mile. The consumption of oil is only 1 liter, or less than a quart, a day.

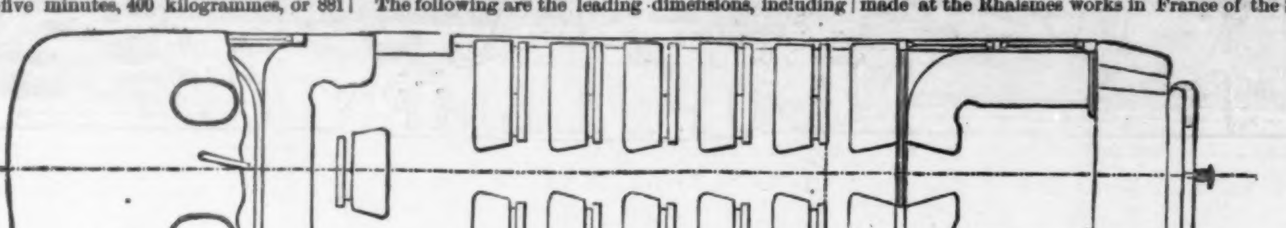


FIG. 3.

The cylinders, 0·13 meter, or 5·1 in., in diameter, and of 0·25 meter, or 9·8 in., stroke, are bolted to the feet of the boiler, this arrangement bringing the whole weight between the two axles, and distributing it uniformly over the four wheels. The weight of the front portion of the body carried by the engine bogie also bears evenly between the two axles, which circumstance, in addition to the horizontal position of the cylinders, causes a remarkably regular and noiseless motion of

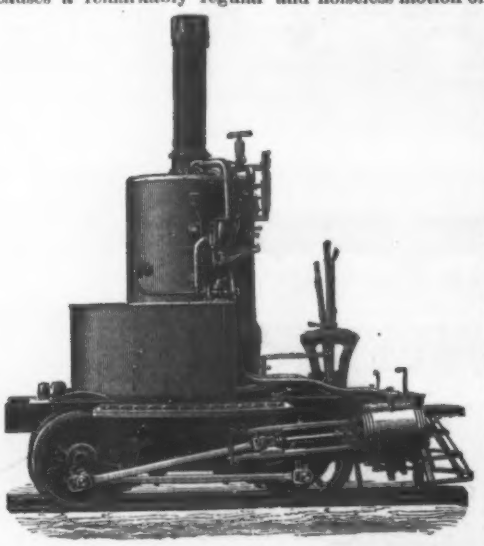
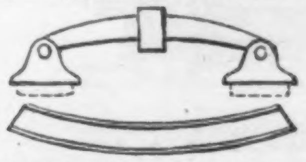


FIG. 4.

the engine. This is a point of the greatest importance, because, combined with the slight weight and low center of gravity, it has great influence in preserving the way. The axles are not coupled, because, with the slight gradients usually encountered in towns, the adhesion of two driving wheels generally permits of drawing a supplementary car. The other pair of wheels can, however, be coupled with a chain, or with side rods in the ordinary manner. The connecting rod brasses are cast with a cap over the end of the crank-pin, for keeping out dust and mud.

Under the seats are placed two feed tanks, composed of copper tubes, one containing cold water, and the other the hot water from the surface condenser, which is placed on the roof. The latter consists of a series of copper tubes, of the form shown in the sketch, presenting about 80 square meters, or 860 square feet, of condensing surface. The parts are hung freely, so as to allow for expansion and contraction, and the surface exposed to the air is sufficiently large to dispense with the necessity of water for cooling. The feed pump is constantly at work circulating the water, which is thus used over and over again, so that a steam carriage can run for forty or fifty kilometers without renewing its water supply. The passengers feel no heat from the condenser or hot-water tank; and the motion of the engine is completely deadened by springs introduced between the engine and the carriage. The thrust of the bearing-springs is received by shoes which slide in segmental guides, shown by the annexed sketch, thus



producing the effect of a radial axle-box. There are two sets of brake blocks, four, worked by pedal, on one pair of wheels for ordinary use, and four, worked by screw, on the other pair for pulling up sharp in case of an emergency. In place of the ordinary clearing iron a bunch of canes is bolted on to the tank. The body of the supplementary car—Cleminson's patent—is carried by three bogies, that in the middle sliding, and those at the ends swiveling, so as to run round curves of 20 meters, or 65½ feet.

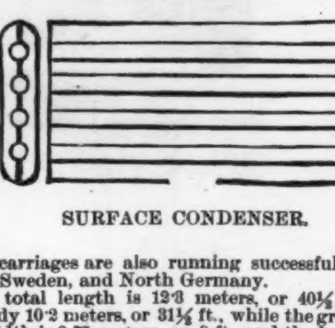
The following are the leading dimensions, including for convenience some given above, and also the relations determined by the jury during the trials:

Length occupied by motor	3 m.	= 9 ft. 10 in.
Length occupied by passengers	6·5 m.	= 21 ft. 4 in.
Weight of fifty passengers, at 70 kilog., or 1 cwt. 1 qr. 14 lb.	3,500 kilog.	= 3½ tons.
Weight of vehicle	2,500 kilog.	= 2½ tons.
Weight of condenser and reservoirs	600 kilog.	= 11¾ cwt.
Weight of vehicle, condenser, and reservoirs, empty, p	3,100 kilog.	= 3 tons.
Relation p weight empty to π weight of passengers	0·886	
Load on motor in running order without passengers	1,400 kilog.	= 27½ cwt.
Load on motor fully loaded	2,900 kilog.	= 2⅞ tons.
t Boiler pressure	13 atmos.	= 195 lb. pr. sq. in.
d Diameter of cylinders	0·13 m.	= 5·1 in.
l Piston stroke	0·25 m.	= 9·8 in.
D Diameter of wheels	0·75 m.	= 2 ft. 5½ in.
E Tractive effort $= \frac{0·5\, td^2l}{D}$	366 kilog.	= 7 cwt.
S Heating surface	5·96 sq. m.	= 64 sq. ft.
G Grate surface	0·29 sq. m.	= 3 sq. ft.
C Condenser surface	80 sq. m.	= 860 sq. ft.
P′ Weight, in running order (motor only)	4,100 kilog.	= 4 tons.
P″ Weight, fully loaded	7,000 kilog.	= 6·8 tons.
Content of water tanks	120 liters	= 26½ gals.
Content of coke boxes	100 liters	= 3½ cub. ft.
Wheel base of motor	1·54 m.	= 5 ft.

$$\frac{P'}{E} = 11·2;\ \frac{P''}{E} = 19·12;\ \frac{P'}{S}\ 688;\ \frac{P'}{G} = 14{,}138;\ \frac{C}{S} = 13·42;\ \frac{E}{C} = 4·57.$$

By adopting this system of steam carriage, the fundamental principle of the tramway, in opposition to the railway, is maintained by running small trains at frequent intervals. As regards brake power, the combined engine and carriage is far more under control than a locomotive drawing a separate carriage, besides occupying less space in the street. An objection has been made that the steam carriage requires turning at each end of the line; but, with a triangle like that laid down at Antwerp, this operation takes up less time than detaching a locomotive, running it by a siding from one end of the train to the other, and again hooking it on. Besides, with the steam carriage there is no door in front, giving rise to draughts, which are much complained of in tramcars.

Fig. 8 shows a larger steam carriage, intended for light railways in the country, and therefore non-condensing, which ran regularly at Antwerp, but was disqualified from competing because no suitable car was found for it to draw in addition to that which forms an inherent part of itself. The seats and awning on the roof were, however, removed, on account of their being too high to go into the shed. This carriage was made at the Rhaismes works in France of the Societe Anonyme Franco-Belge pour la Construction de Materiel de Chemins de Fer, and has been bought by the Societe Generale des Chemins de Fer Economiques to run between Turin, Settimo, and Rivarolo. Similar



DOUBLE BOILER.

SURFACE CONDENSER.

steam carriages are also running successfully in Denmark, Sweden, and North Germany.

The total length is 12·8 meters, or 40½ ft., and of the body 10·2 meters, or 31½ ft., while the greatest outside width is 2·75 meters, or 9 ft., and the height from rails to top of chimney 4·76 meters, or 15½ ft. There

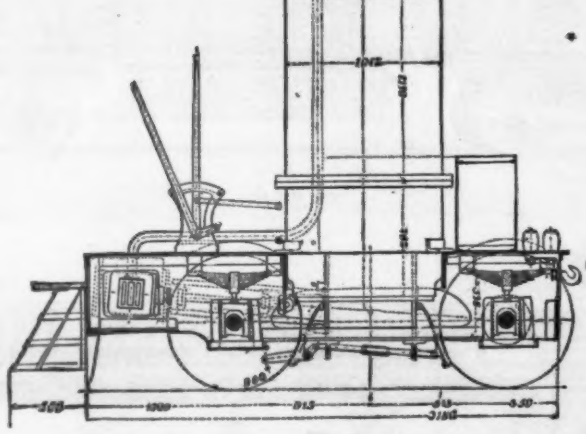


Fig. 5

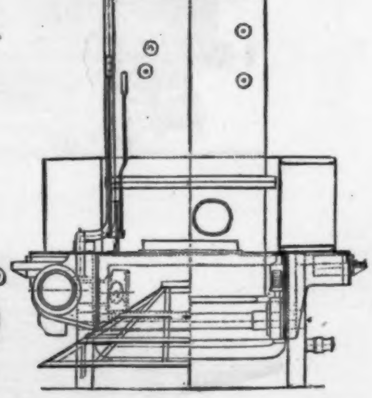


Fig. 8

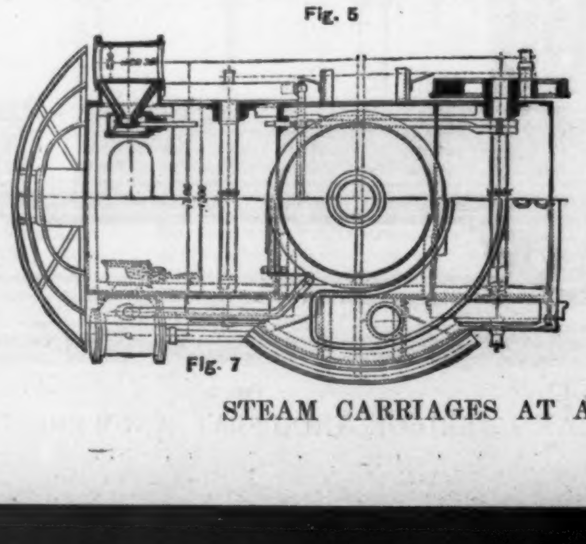


Fig. 7

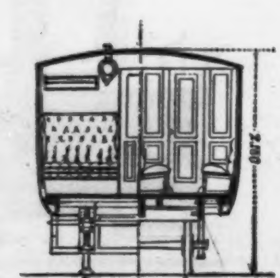


Fig. 12

STEAM CARRIAGES AT ANTWERP.

are altogether eighty places, besides the luggage compartments. The total weight in running order is 15⅛ tons, and when fully loaded the weight available for adhesion is 15 tons, the tractive force of the engine being 1·7 tons. This steam carriage will mount a gradient of 1 in 25, run round a curve of 30 meters, or 33 yards, radius, and attain a speed of 30 kilometers, or 20 miles, an hour on the level, with a consumption of 2½ kilogrammes of coke per kilometer, or about 9 lb. a mile. All four wheels are coupled, and the brake acts upon two axles only, or all four in case of emergency. With dry rails, and going at a speed of 20 kilometers, or 12½ miles, an hour, the carriage may be pulled up in a distance of 20 meters, or 22 yards. Steam can be got up in the tubular boiler in half an hour. The cylinder is 0·23 meter in diameter, and the stroke 0·33 meter, or 9 in. by 13 in.

Figs. 9, 10, 11, and 12 show a similar carriage, made at the La Croyere works of the Franco-Belgian Construction Company above mentioned, which runs regularly on the Brussels Ceinture line of the Belgian State Railway, between the Luxemburg Station and Schaerbeck Junction. This, too, has no imperiale or seats on the roof, but compartments for all three classes, besides one for luggage. The total length outside buffers is 13·45 meters, or 44 feet, affording space for the engine, a luggage compartment, a first-class compartment of eight places, a passage for entrance, a second-class compartment of twelve places, a third-class ditto of twenty-eight places, and a plantform giving access and also standing room for twelve passengers—sixty altogether; while below is a large space where parcels may be stowed. The steam carriage, which weighs empty about 16 tons, including the 7-ton engine, makes 30 kilometers, or 20 miles, an hour, but can attain a speed of 40 kilometers, the coke and water space being sufficient for 20 kilometers, or 12½ miles, while curves of 120 meters, or 131 yards, radius are easily turned.

The following are the principal dimensions:

Grate surface	0·256 sq. meter	=	3 sq. ft.
Total heating surface	17· "	=	183 "
Number of tubes			190
Diameter of cylinders	0·205 meter	=	8 in.
Stroke	0·33 "	=	13 in.
Diameter of four-coupled wheels	0·82 "	=	2 ft. 8¼ in.
Between axles of engine truck	1·83 "	=	6 ft.

The motion is very easy, even on a badly laid line, and but little time is lost in stopping, while the engine soon gets into speed after starting.

As Captain Douglas Galton observed in his paper before the Society of Arts, "If tramways are to fulfill their object satisfactorily, it must be by mechanical traction;" and when once the "interference from a centralized bureaucracy" is removed, Rowan's steam carriage may be expected to afford a practical solution of this question in England, as it has already done in Denmark, Sweden, Germany, Italy, and Belgium.—*The Engineer.*

Fig. 9

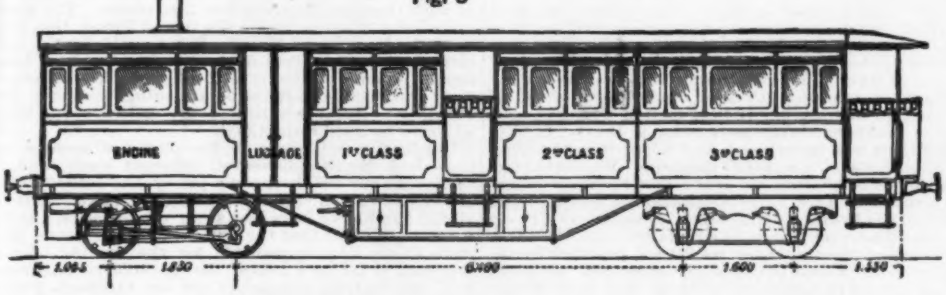


Fig. 10

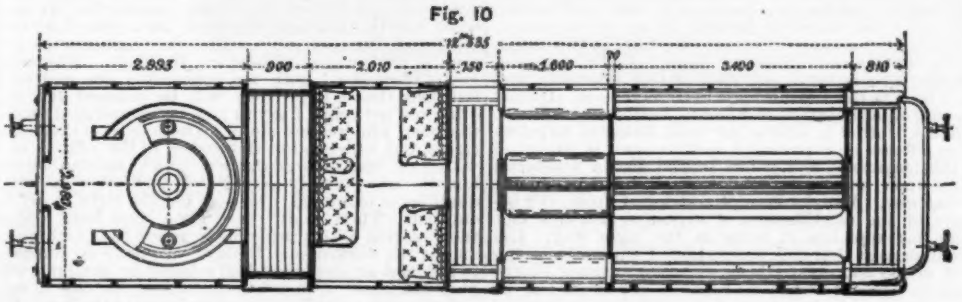
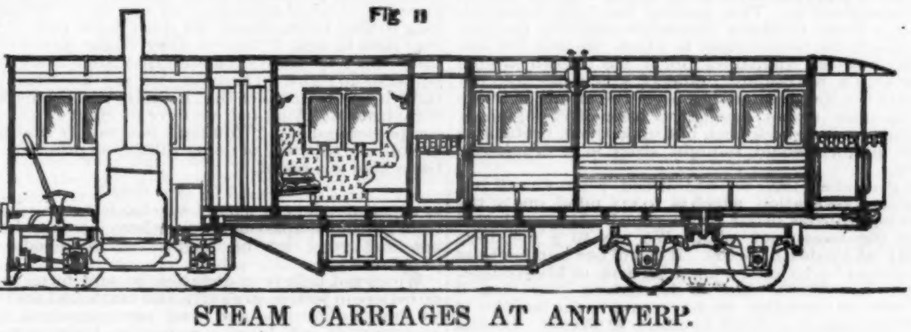


Fig 11



STEAM CARRIAGES AT ANTWERP.

HOISTING CABLES.

It was found by the census officials that out of 420 deep mines in the United States, 38 used flat steel cables, 171 round steel cables, 8 both flat and round steel cables, 180 used hemp or Manila rope, and 17 both steel and hemp rope. In California, 42 out of 65 used round steel rope. In Nevada, out of 73 deep mines, 27 used flat steel rope, 25 round steel, and 14 hemp or Manila, while 7 used both metal and hemp. The Manila or hemp ropes are used only in comparatively shallow workings and where moderate quantities of ore are raised. The largest reported in the State of Nevada was three inches in diameter, and raised an average load of 2,200 pounds, including weight of cage. The smallest was 1¼ inches in diameter, and raised but 250 pounds. Hemp and Manila cables last from 3 to 18 months, and average from 10 to 12 months.

A few mines use round tapered steel cables. The tapered cables are 2¼ inches at top and 1¼ inches at bottom. While so far as the distribution of the load is concerned tapered cables present a decided advantage, they are much less readily repaired, and cannot be reversed. They were much more used a few years ago than they are now.

A dozen or so years ago, steel cables were introduced but slowly. Though their advantage was great, they were apt to give out unexpectedly and without warning. The difficulties of making a steel wire suitable for the purpose have been overcome, and there are now but few iron cables left. For large cables the flat is preferred to the round. A heavy round cable must be wound on an enormous drum to escape injury by bending, while the flat rope can go on a reel of small width, and of no greater diameter than would be used for round. These advantages more than counterbalance the slight additional weight of metal necessary to obtain the same strength as the round cable would possess. The largest steel cable reported was one on the Comstock, ⅝ of an inch thick and 8 inches broad, carrying a load of 15,800 pounds. The average load for steel wire ropes, except in Nevada, is a ton and a quarter, but on the Comstock it is about three tons.

The following is a partial list of Comstock hoisting cables, showing weight of load, average duration, particulars as to sheaves, etc., and will be of interest to all mining men:

Belcher.—Flat steel wire cables, 4 in vertical shaft, each 1,000 feet long, 3½ inches by ½ inch; 2 in incline, each 2,000 feet long, 5 inches by ½ inch. Average load, including cage, 5,300 pounds. Average duration, with repairs, 3 years. Sheaves, 50 feet high, 7 feet in diameter.

Belcher and Crown Point Pump Shaft.—In hoisting compartment, flat steel wire cable, 5 inches by ⅝ inch, 5,300 feet long; in pump compartment, round steel wire cable, 1 inch in diameter, 1,000 feet long. Average load, including cage, 5 tons. Average duration, with repairs, 4 years. Height of sheaves, 30 feet; diameter, 6 feet.

Crown Point.—Five flat steel wire cables, 5 inches by ½ inch; one round steel wire cable in incline, tapering from 2¼ inches to 1¼ inches in diameter. Average load, including cage, 5,500 pounds. Average duration, with repairs, 4 years. Height of sheaves, 18 feet; diameter, 7 feet.

Forman Shaft.—Two flat steel wire cables, one English make and one American, each 3,000 feet long, 6 inches by ⅜ inch. Average load, including cage, 5 tons. Height of sheaves, 50 feet; diameter, 10 feet.

Overman.—Flat steel wire cables, one 5 inches by ½ inch, 1,700 feet long; one 4½ inches by ½ inch, 1,700 feet long; two 4 inches by ½ inch, 350 feet long. Average load, including cage, 4,700 pounds.

Yellow Jacket.—Flat steel wire cables, each 3,700 feet long; two hoisting compartment cables 8 inches by ⅝ inch; pump compartment cable 6 inches by ½ inch. Average load hoisted, including cage, 15,800 pounds. Large double-decked cages, with space for two cars on each floor, weighing 5,000 pounds; weight of four cars, 900 pounds each, 3,600 pounds; weight of four carloads, 1,800 pounds each, 7,200 pounds. Without mending, cables lasted 3 years. Height of sheaves to centers, 55 feet; diameter, 15, 12, and 7 feet.

Combination Shaft (Chollar, Hale & Norcross, Potosi, and Savage).—Flat steel wire cables, 6 inches by ½ inch. Average load, including cage, 5,500 pounds. Average duration, 14 months. Height of sheaves, 50 feet; diameter, 18 feet.

Consolidated Virginia and California Joint Shaft.—Flat steel wire cables; two in hoisting compartments, 7 inches by ⅝ inch; one in pump compartment, 5½ inches by ½ inch. Average load, including cage, 12,400 pounds. Three-decker cages, weighing 4,000 pounds; three cars, 1,200 pounds each, 3,600 pounds; three carloads, 1,600 pounds each, 4,800 pounds. Average duration, 18 months. Height of sheaves, 45 feet; diameter of hoisting compartment sheaves, 11 feet; diameter of pump compartment sheave, 6 feet.

Hale & Norcross.—Flat steel wire cables, 5 inches by ½ inch. Average load in vertical shaft, including cage, 3,000 pounds; in incline, including giraffe, 5,500 pounds. Height of sheaves, 36 feet; diameter, 8 feet. Incline cable lasts only 6 months.

Ophir.—Two flat steel wire cables, 5 inches by ½ inch, in vertical shaft; round steel wire cable in incline, tapering from 2½ inches to 2 inches. Average load, including cage, 8,600 pounds. Weight of double-decked cage, 3,000 pounds; two cars, 1,200 pounds each, 2,400 pounds; two carloads, 1,600 pounds each, 3,200 pounds. Average duration with repairs, 2 years. Height of sheaves, 30 feet; diameter, 7 feet.

Osbiston Shaft (Best & Belcher and Gould & Curry Joint Shaft).—Two flat steel wire cables, each 2,500 feet long, 5 inches by ½ inch. Average load, including cage, 7,000 pounds. Average duration with repairs, 4 years. Height of sheaves, 30 feet; diameter, 6 feet.

Savage.—Two flat steel wire cables in vertical shaft, each 1,500 feet long, 5½ inches by ⅝ inch. Round steel wire incline cable, 4,000 feet long, 2¼ inches diameter. Average load in vertical shaft, including cage, 3,600 pounds; in incline, including giraffe, 5,000 pounds. Average duration with repairs, 3 years. Height of sheaves, 40 feet; diameter, 6, 8, and 15 feet.

Union Shaft (Mexican, Sierra Nevada, and Union Consolidated Joint Shaft).—Flat steel wire cables; two in hoisting compartments, 7 inches by ½ inch; one in pump compartment, 5½ inches by ½ inch. Average load hoisted, 13,500 pounds, including three-decker cage, 4,500 pounds; three cars, 1,200 pounds each, 3,600 pounds; three carloads, 1,800 pounds each, 5,400 pounds. When bailing, hoist 1,000 gallon iron tank weighing, shell and water, 9,812 pounds. Average duration with repairs, 4 years. Splices are from 75 to 100 feet long. "Cables wear most rapidly at points over sheaves corresponding to distances of stations; the wear is also more rapid when there is an over and under bend on reel and sheave." Height of sheaves to center, 45 feet; diameter, 12 feet.

Utah.—Flat steel wire cables; vertical shaft cables, 4 inches by ½ inch; incline, 6 inches by ½ inch. Average load in vertical shaft, including cage, 3,500 pounds; in incline, including giraffe, 9,000 pounds. Average duration with repairs—vertical shaft, 5 years; in incline about 2 years. Height of sheaves, 25 feet; diameter, 6 and 8 feet.—*Min. and Sci. Press.*

FATE OF THE "STEVENS BATTERY."

If any of the millionaires who are owners of the new Queen Anne cottages at Babylon, Bay Shore, or some of the other summer resorts on Long Island, were to be told that their handsome woodwork finishings are merely remnants of the old "Stevens Battery," the statement would probably be received with many doubts. Yet such is the fact. A few remarks on the dimensions and general appearance of the vessel will probably not be amiss.

Length over all	401	feet.
Length between perpendiculars	390	"
Breadth	45	"
Breadth over armor	54	"
Depth to main deck	24½	"
Draught maximum, fore and aft	22	"
Displacement at 22 ft. draught,	6,006·02	tons.
Area of immersed midship section,	890·26	sq. ft.
Ratio of immersed midship section to circumscribed parallelogram	0·867	
Ratio of displacement to circumscribing parallelopiped	0·544	
Number of steam cylinders	4	
Diameter	72	inch.
Stroke of piston	43	"
Number of screw propellers	2	
Diameter " "	18	feet.
Pitch " "	27	"
Number of boilers	10	
Area of heating surface	28,000	sq. ft.
Area of grate surface	876	"

The general appearance of the vessel, if completed as Professor Thurston recommended, would have been of a monitor ironclad. The proportions of length to breadth, 8·666 to 1, is that now usually observed in sea going, high powered steamers, and is somewhat less than in those which represent the extreme limit yet attained.

The lines are fair and fine, giving a sharp bow and the fine run, which is essential to the efficient working of screw propellers. The proportions of the midship section, which has a breadth equal very nearly to double the intended draught, were such as are best calculated to make the vessel easy in a sea-way. Seven transverse bulkheads were built, dividing the ship into distinct water-tight compartments. Two additional ones were carried across the ship below the berth-deck. Coal bunker bulkheads forward and aft, and several smaller ones in the extreme ends of the vessel, still further strengthened the structure. The hull was made still stronger by the bulkheads of the turret chamber, which stiffened the whole structure by tying the decks, the coal bunkers, and the lower longitudinal bulkheads firmly together. When Mr. Stevens presented the famous vessel to the State of New Jersey, the United States Government decided that a man of war could not be accepted as the individual property of any State. Mr. Stevens then offered it to the National Government, but it was refused as being inadequate to perform the duties required of a war ship. Several suits followed this decision, between the estate of Mr. Stevens and the State of New Jersey, which claimed that although it could not hold the vessel it was entitled to its value in money. The final decision was in favor of the State, and the "Stevens Battery," as it stood on the ways, was sold to Wm. E. Laimbeer, of New York

city, for $55,000. The heirs of Mr. Stevens say that he spent over $2,000,000 upon his pet object in addition to $500,000 allowed by the Government. In his will was a codicil ordering the expenditure of $1,200,000 making the total cost of the vessel $3,700,000. Mr. Laimbeer was given six months to remove his purchase, but for half of that time he turned it over to the Stevens Institute of Technology, for the use of its students. In consequence, Prof. R. H. Thurston was able to give his pupils three months of the most interesting practical study that has ever been available in this part of the country.

The dismantling of the hull occupied the balance of the time allotted to the purchaser. On no day during this period were there less than 40 men at work, while at times the number ran up to 100. The woodwork was all found to be of the finest Georgia pine in high state of preservation. That used in the sides of the hull was in layers to the thickness of 5 ft. 6 in. These layers were dovetailed together and secured by bolts 4 ft. long. In and around these joinings creosote was packed in large quantities, and, although this wood had been in place for more than 20 years, it was found to be in better condition than when freshly cut. All the skill of the workmen and the strength of tools could not force the layers of wood apart, and the work was finally done by burning. It was found to be exceedingly dry and susceptible of high polish, and, as has been stated, a large quantity of it has been used in the new cottages built and building on the south shore of Long Island. From the hold were taken two engines of 6,000 horse-power each, made expressly for use in a twin screw vessel, and, therefore, worthless. These were broken up and sold to the Delamater Iron Works, from whence they came. In addition to the two propelling engines, there were sixteen driving engines, which were preserved intact and taken to the coal mines in Pennsylvania, where they are still used as superior to any new inventions. Over 2,000 tons of iron plate were taken from the vessel and sold to the Catalssagua Iron Works, in Pennsylvania, and 33 per cent. of it was rolled in this country. The balance was sent abroad. The bolts used in the construction of this vessel were made in Scotland for that purpose and possessed unusual tensile qualities. These were in good condition after their long years of service and were shipped to England, where they were used in the manufacture of shot-gun barrels. When all the movable articles had been carted away, the two pointed ends of the boat were chopped off and the immense hull parted with its own weight. The labor of collecting the remnants was then comparatively easy. Immense quantities of giant powder were used, however, to reduce the bulk of the iron to a mass small enough to be carted away. There remains intact to-day but one article that was used on board the "Stevens Ironclad Battery." It is a large bronze bell 4 ft. in circumference, and hangs in the tower of a school-house in Tenafly, New Jersey.—*The Stevens Indicator.*

THE AIMS AND OBJECTS OF THE BROTHERHOOD OF LOCOMOTIVE ENGINEERS.*

By P. M. Arthur.

More than 800 locomotive engineers were in Hartford in attendance upon the "union" meeting of the Brotherhood of Locomotive Engineers, on April 25. They came from thirty-one different divisions, representing Massachusetts, Maine, New Hampshire, Virginia, South Carolina, New York, New Jersey, Pennsylvania, Canada, East St. Louis, Rhode Island, and Connecticut. This was what is called a "union" meeting, held in accessible places about once a year. It is not the annual meeting. The object of union meetings is to discuss whatever matters may be of interest to members, and to seek the advancement of the order; for the brotherhood is in every sense a progressive one.

Allyn Hall was filled in the evening by an audience anxious to learn of the aims, objects, and methods of the brotherhood, and to Grand Chief Arthur was given the closest attention. The meeting was called to order by Chief James A. Brennan, of the Hartford division, who presided and introduced the speakers. Grand Chaplain Everett, of Philadelphia, opened the session with prayer. Chief Arthur was the principal speaker of the evening. He is a ready speaker, presents his ideas in a very forcible, convincing manner, and appeals effectively to the intelligence and manhood of the workingmen. Many times he was interrupted by applause.

CHIEF ARTHUR'S REMARKS.

This, perhaps, is to many good people of Hartford an unusual gathering for a Sabbath evening; but I trust that, as you go from here, you may feel that while some of you have absented yourselves from your churches, your time will have been profitably spent. I can assure you, ladies and gentlemen, that you will learn no evil here. It is unfortunate that we, as railroad men, have to seek the Sabbath day to hold our meetings in order to get any great number of our members together. We belong to that unfortunate class of men who are called upon to perform duty upon the Sabbath day as well as upon the week day. Locomotive engineers cannot, when they please, leave their engines and attend to their own personal affairs, as is the privilege of the merchant, the professional man, or even the man in the shop. We cannot stop our trains. The public demand that they be run, and we must obey. Hence we seek to hold what we call "union" meetings on Sunday, knowing that by so doing we get a much larger number of engineers together.

When I was invited to come here to Hartford to hold a meeting, I was asked whether or no it would be best for us to hold a public meeting in the evening. I replied that if the people in Hartford are not acquainted with our order, then by all means let us have a public session. Because, we want the public to know what our brotherhood is and what our aims, our objects, and our purposes are; and we willingly leave it for you to form your own opinion as to whether we are entitled to the support of the public.

Like all other organizations, we have had a beginning, and ours was indeed a small one. And I think what I shall say concerning our organization ought to convince the workingmen at least of the necessity of being well organized, and then of having that organization intelligently conducted so as to protect your interests. In no other way can the laboring men protect their interests so well as by well organized effort.

ORIGIN OF THE BROTHERHOOD.

Twenty-three years ago this month the Brotherhood of Locomotive Engineers was founded in Detroit, Michigan. The first division consisted of twelve members. The idea was conceived by a few men employed on the Michigan Central Railroad, who realized the necessity of doing something to ameliorate the condition of locomotive engineers. It was known as the "Brethren of the Footboard," a very appropriate name for those days. Then the idea seemed to prevail that all that was necessary to belong was to be an engineer; and when the brotherhood had become established, the idea was that the principal aim of it was to dictate to the railroad companies what they should do and what they should not do. The founders of this brotherhood had never intended it for any such purpose. Our motto is, "Do unto others as you would that others should do unto you"—the golden rule. A short time after No. 1 was founded, they started out to organize divisions in different sections of that State and other States, and before long twelve divisions had been established, and in accordance with a previous arrangement among these subdivisions, the national division was formed. Twelve delegates assembled in Detroit, and created what was known at that time as the "Grand National Division of the Brethren of the Footboard."

As time went on, division after division was formed, until at the close of August, 1884, we held our first convention in Indianapolis with 44 delegates. We realized at that time that something was necessary to be done for our brethern across the line; so at that convention the name was changed to the "Grand International Division of the Brotherhood of Locomotive Engineers," so that men in Canada might become members. At the convention in Boston, in 1866, a resolution was introduced and adopted authorizing the publication of a monthly magazine. We started out with the determination to make our monthly magazine a success. This little publication of ours finds its way into the homes of thousands of engineers all over the continent, and to-day its circulation is 17,000. It is the means of disseminating useful and practical knowledge of great benefit to locomotive engineers; its pages are open to all its members, wherein they may express their opinions as locomotive engineers. Here you may also find the names and numbers of our subdivisions. We call them divisions instead of unions or lodges. "Division" is a railroad term. We have in this magazine a list of all our divisions, their location, names of officers; also, a list of all men of bad character who have been in the brotherhood and have been expelled because of intoxication, dishonesty, or immoral conduct. When a brother is, after a fair trial, found to be guilty of an offense, he is punished and his name is published in this magazine; and it has indeed had a wonderful effect upon many men who were inclined to go the wrong way. Many a man is restrained from evil because of the mortification of exposure, and this fact alone has kept lots of them in the right way. You might suggest that this was unjust. I answer by saying that we do not do anything with the member except what he agrees to when he becomes one of us, and he can never find fault with us for doing what he himself has subscribed to. This method has been beneficial, not only to the members themselves and their families, but also to the communities in which the men live and to the railroad companies; for it has thrown around these men a restraining influence which has been felt all over the country and has been the means of building up many a man among the locomotive engineers. Had not such a check been put upon them, probably a large number would to-night sleep in a drunkard's grave.

In December, 1867, we established what we call our insurance association, which is, to my mind, one of the grandest features of our brotherhood. It is conducted upon the assessment plan. We pay to a member's family, at his death, $3,000. If one of our number be so unfortunate as to loose a hand, an arm, or his eyesight, we pay him $3,000. And in the sixteen years that it has been in operation, we have paid to the families of members, and to injured members, $1,850,000. Besides this, we have paid to needy and distressed engineers $500,000. The brotherhood has elevated the locomotive engineers of this country so that they have become a credit to themselves and the railroads. Twenty-five years ago, and I say it indeed with regret, a railroad man as a rule was regarded with distrust, and men ran their engines often under the influence of liquor. In 1853, when the roads were consolidated between Albany and Buffalo, it was then called the New York Central. I remember when that company gave the members of the Legislature an excursion over the road from Albany to Niagara Falls. On the return trip into Schenectady, where I lived, the crew of the train each received from the superintendent $5, and I don't think there was one of those men who did not have a grand drunk on that money. Now, all this has been changed. It was then customary for all the eating rooms along the line of railroads to sell liquors, and it was always considered proper for all the men of a train

TO TAKE A DRINK

whenever they felt like it. To-day no locomotive engineer who has any regard for the brotherhood will be guilty of doing anything of that kind.

We have given to the railroads reliable, trusty engineers. "But," some persons may say, "you engage in strikes." Yes, that is true. We have not yet reached that point where we class ourselves under the head of anti-strikers. And I don't want any of you to forget that. But it is unfair to condemn any man upon *ex-parte* statements. First learn whether the man be guilty before you pass judgment. In Scotland, you know, they say, when a man is tried and not found guilty, "not proven." We have had strikes, I admit, but what caused them? Let me explain the policy of this brotherhood as affecting those relations that should exist between employer and employe. We have on all well regulated railroads what we term a "grievance committee." When a grievance arises between the engineers and the company (and differences will arise just so long as there is capital and labor), the great problem to-day is how to adjust them. My motto is, in the language of St. Paul, "Come, let us reason together," and if we can get the parties to look at it in that light, we will have no strikes. Let the men come together and discuss their differences, and then come to an understanding. Let the employer give the men under him to understand that he is interested in their welfare, and not that he considers them mere senseless machines. This policy of the brotherhood is one of the best, and, I am glad to say, it has been copied by some other organizations springing into life during the past few years, with excellent results.

When a difficulty arises, whether a question of wages or of runs, it is the duty of the "grievance committee" to wait upon the officers and use all honorable means to effect a settlement. If they fail, it is their duty then to send for the chief executive of the brotherhood. It then becomes his duty to respond to their call, seek an audience with the officers of the road, and exhaust all his efforts to seek an adjustment. If he fails, and it is his belief that the men should strike, he gives his consent; and that carries the support to the entire brotherhood. Whenever, during the past twelve years, we have been met by the officers of the roads, there has been no strike. Every strike by us has been caused by the blunt refusal, on the part of the roads, to recognize us. Now, who is to blame for the strikes we have had? For the first two years I was in office, we were

CALLED UPON TO SETTLE SIXTEEN

different cases, and we were successful in all of them. But we came to one case where, upon our proposition to talk the matter over, we were sharply met with, "I won't receive your committee nor have anything to do with them." That was the first strike. The same cause led to the trouble on the Grand Trunk line, and upon the Boston and Maine. What could we do, and still consider ourselves as men, when we had been promptly and positively refused recognition in every way, even for the purpose of adjusting amicably the difficulty? But since then, every difference has been adjusted by our brotherhood.

During the excitement of the past few months we have had disputes on seven different roads, and in every case our brotherhood's policy has settled them all. I have given you, my friends, the naked facts of all the trouble we have had as an organization; and I say here to-night that the officers of those roads, and those alone, were responsible for the trouble. I can say that, as far as I know, the locomotive engineers and the railroad companies are on excellent terms. The Connecticut River and Vermont Central roads advise their engineers to remain outside the brotherhood, and this advice is followed. As a reward for this obedience, the companies reduce the engineers ten per cent. in their wages. These are the facts. Whenever any of them speak with me concerning the matter, I tell them that I hope they will be reduced still another ten per cent. I say to you, ladies and gentlemen, that men who will not stand up in defense of their own rights, but who bend to the wishes of the officers and withdraw from an organization which no man who is honest can possibly object to, lack the essential qualities of manhood. No man has the right to say to another, "Thou shalt" or "Thou shalt not," and in the violation of this principle is where the trouble lies among the workingmen to-day. We have no business to say that an employer shall employ or shall not employ this man. A man has the right to belong to any organization provided it is not contrary to the law. We have had railroad managers tell our men, "If you belong to that brotherhood, we don't want you." As to that class of men, I believe they ought not to have their own way always, because they are not always inclined to do right. Therefore, we say no man has a right to say to another that he must not belong to an organization. And, too, we have no right to go to the companies and say, "You must not employ that man." We oppose this way of doing things, on principle. Unless a man is a rascal,

YOU HAVE NO RIGHT

as superintendent or master mechanic to prevent him from getting employment elsewhere because he does not suit you; for he might suit somebody else. [Applause.]

We do not believe in dictation in any form, but we do believe in justice, in equity, and truth, and that when we have a difference and send our committee to the company, it will have a respectful hearing and be allowed to sit down and talk the matter over. Whenever this has been done, a satisfactory agreement has been the result. Some time ago we were in Chicago. We had a meeting with Mr. Potter, representing over 5,000 miles of road, and the committee numbered seventeen men. After several days of conference an agreement satisfactory to all concerned was reached, covering that entire distance. Who can object to a policy of that kind? The great trouble is there has been too great a chasm between capital and labor, and we should strive to bring them closer together. There should be no antagonism. There is no occasion for it. And though I want every laboring man to hold up his head and look his employer squarely in the face, yet I want him to remember that capital, as well as labor, has rights which we must respect. [Applause.] We cannot do without either. Both are essential to the prosperity of the country. There should be no clashing between them—there need be none.

As I said, I do not believe the workmen are disposed to pass judgment upon a man without first hearing from him. Not long ago I was called to Houston, Texas. Our men had some differences on the Houston and Texas Central road, and we were sent for. We went there, and on our return we missed the connection at St. Louis. We then went to a hotel, registered, and went into supper. When we came out, the clerk said half a dozen newspaper men were in waiting to talk with me. The trouble in East St. Louis was then in progress. I told the clerk that I should talk with no person whatever while in St. Louis. Now, newspaper men are as a rule pretty sharp fellows, but now and then they are too smart—they overdo the thing. The next morning we took the early train for Cleveland, where I live. Our train was delayed on the way, so that I did not reach home until late in the afternoon. Some of my friends seeing me, exclaimed in surprise, "Why, I thought you were in St. Louis; the papers say you are there!" I found in the Cleveland *Leader* a long statement, purporting to come from that paper's

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* Address by P. M. Arthur, Grand Chief, delivered at a union meeting of the Brotherhood of Locomotive Engineers, at Allyn Hall, Hartford, Conn., on Sunday evening, April 25, 1886. From the Hartford *Daily Times.*

correspondent in St. Louis, saying that I was there in close communion with the Knights of Labor. Now, a good many railroad men believed that story. The fact is that while in the city of St. Louis, I did not speak to any individual except the hotel clerk. So much for that.

Again, I have been quoted as opposed to the eight hour law and as saying that it would give the workingmen two hours more for drinking and carousing. That is false. [Applause.] The workingmen ought to know me better than that, seeing I have been before them for so many years; and I challenge any man to put his hand on any action of mine which reflected discreditably upon them. [Applause.] I never have posed as a labor reformer, and I have no use for those men who do, for they are demagogues. Men are known by their works, as are trees by their fruit. When the trouble in Boston was in progress in 1877, men came to me and said, "Now is your time; you can be carried into public office on a high political wave." I replied that I wanted no political office; that it was honor enough for me to be the chief of this brotherhood. [Applause.] I tell you, my friends, when a man who is looking up as the leader of a labor organization, just so soon as he begins to dabble in politics then it is time for you to request him to resign, and put another man in his place. They care for themselves far more than they do for those whom they represent. Where is the blacksmiths' union? What has become of the coopers' union? And where is the union of the miners? The political ambition of their leaders caused them to fail of their object as unions.

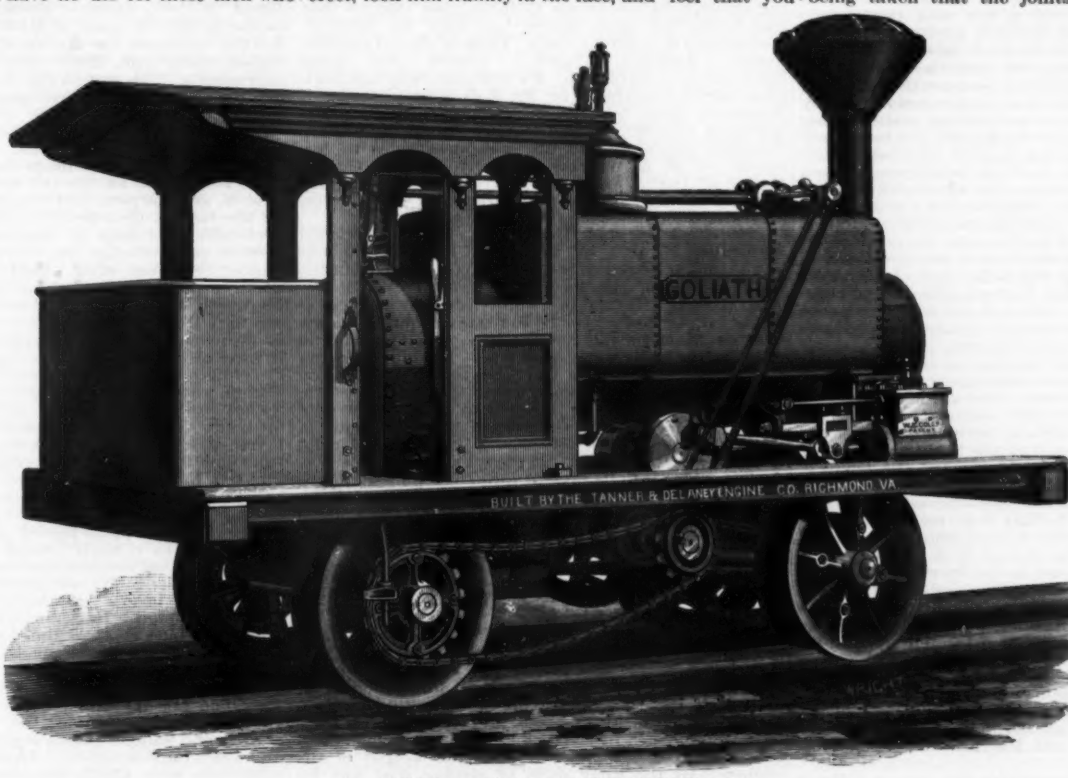
What I did say about the eight hour law was this: "If the masses want eight hours for a legal day's work, give it to them for a fair trial; but I fear there are a large number of men who will not profit by it." Many of those sometimes called workingmen do not make good use of their time. I believe in working. Since I was 12 years old I have worked. And to that question I have never given any consideration further than to say, "Make the best use you can of the time God gives you; and if you want an additional two hours for the purpose of improving your mind, then I hope the law givers of the land will give it to you, and that you will appreciate it, and not loiter it away as many men do, I am obliged to acknowledge." My advice is, be sober, be frugal, be industrious, and practice a little self-denial for the benefit of those who are dependent upon your daily earnings. Above all, keep out of whisky shops, shun dens of infamy and the gambling table, and spend your time with your wife; and if you have no wife, and are old enough to get married, I advise you to get one right away. [Laughter and applause.] We were the first to form an association among railroad men, and now I am glad to know that we have the "Order of Railway Conductors," "The Brotherhood of Locomotive Firemen," "The Brotherhood of Brakemen," "The Yardmasters' Association," and an "Association of Superintendents"—all banded together for one purpose, and that purpose, so far as I have information, is the same as ours—to protect our interests and to promote our welfare; and I say God speed them all!

Now we have another organization that has sprung up, and since it has come into existence we have heard a great deal about it. It is called the Knights of Labor. It is an honorable name, and if any of them are here to-night, to them I say, if you expect to succeed and prosper, carry out the golden rule that I have spoken of this evening. Do unto others as you would they should do unto you, and your organization will succeed and prosper.

BE FAITHFUL AND JUST

to your employers; be true and faithful to the principles of your organization; and after having rendered the service due to your employer, hold yourselves erect, look him frankly in the face, and feel that you are his peer. It is not clothes that make the man, but it is character; and without the latter no man nor organization can do anything but go down. So I say get character, and when the individual has character, the association of which he is a member will also have character. Unless you have character it will be but a little while before you will be forgotten. I trust now, my friends, that you all understand the position of P. M. Arthur on the eight hour law and also on all other labor questions. I am proud to know that the laboring men of this country are banding together for the purpose of protecting their own interests; and if they conduct themselves like men, they will command the respect of all fair-minded men, and as for the rest, you need care nothing about them. [Continued applause.]

Following Chief Arthur, remarks were made by Grand Chaplain Delos Everett, of Philadelphia; Brother Fennel of Oswego, N. Y., known as Shandy McGuire; and Brother Dennis McCarthy, of Providence, the temperance speaker; all of whom were heartily applauded. Brother Everett Stevens, now one of the railroad commissioners of Massachusetts, declined to speak on account of the lateness of the hour. After closing prayer by Chaplain Everett, the large audience went away with profound respect for the Brotherhood of Locomotive Engineers and its chief officer.



A POLE ROAD LOCOMOTIVE.

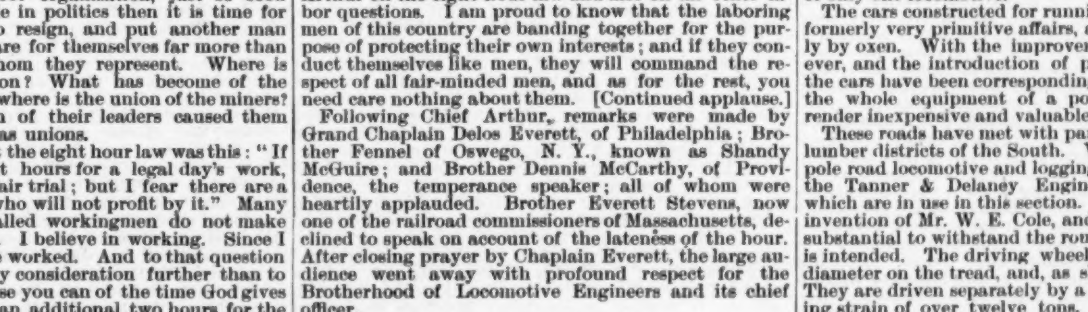
POLE ROADS AND LOCOMOTIVES.

As its name implies, the pole road is a tramway in which the usual iron or steel rail is replaced by poles in their natural state as they are brought from the forest. The principal service of such roads is for logging or other temporary purposes. They have been in use in different parts of the country for over twenty years, and have been constructed in almost every imaginable degree of crudity. It is only recently that they have been so far perfected as to possess any engineering interest. A first-class, substantial road built of poles will cost anywhere from seventy-five to two hundred and fifty dollars per mile, according to local circumstances. The poles employed for rails should not be less than nine inches in diameter at the smaller end, and should consist as far as possible of the heart, or they will decay before they wear out.

In the best roads, a bed is hollowed out in the butt end of the pole to receive the small end of the one adjoining, so as to make a secure junction. The bed is made about nine inches in length, and deep enough to permit the smaller end to come up flush with the larger. The poles are simply laid on top of the ground, except when the surface is very uneven, dirt thrown on each side and trampled down to form a solid bed. After they are in place, they are slightly trimmed down with an adz. When a crook of any kind occurs in the poles, it is of course turned down in laying the track. No cross ties are necessary, as the locomotives and cars are so constructed that they exert no lateral pressure. After a few trains have passed over the road there is no fear of the poles becoming displaced. Curves are made up of a succession of short poles, care being taken that the joints come opposite to each other. The switching is readily accomplished in the ordinary way. Where heavy grades are encountered, it is the practice in some localities to place the locomotive in the middle of the train, and at the particularly steep grades to cut away half the train, push up the other half, uncouple, and return for the remaining cars. In this manner, trains of six loaded cars have been taken over grades of 700 feet to the mile with the use of only one locomotive.

The cars constructed for running on these roads were formerly very primitive affairs, and were drawn usually by oxen. With the improvement of the road, however, and the introduction of pole road locomotives, the cars have been correspondingly bettered, until now the whole equipment of a pole road enables it to render inexpensive and valuable service.

These roads have met with particular success in the lumber districts of the South. We illustrate a form of pole road locomotive and logging car manufactured by the Tanner & Delaney Engine Co., of Richmond, which are in use in this section. The locomotive is the invention of Mr. W. E. Cole, and is made particularly substantial to withstand the rough service for which it is intended. The driving wheels are thirty inches in diameter on the tread, and, as shown, are very heavy. They are driven separately by a chain having a breaking strain of over twelve tons. The motive power is transmitted from the crank shaft of the engine to the master shaft, on which the driving sprocket or chain wheels are keyed, through a spur and pinion of large pitch and face. The axles are mounted on a double spiral spring, and may be adjusted for any stretching of the chain. A water tank of five hundred gallons capacity is mounted over the boiler. It is a special feature of the machine that the driving wheels move independently of each other, both as regards their rotation and lateral play. Each is driven separately from the master shaft, and will perform its function of draught without regard to the work of the other wheels. The whole of the machinery is mounted in a flexible manner, so as to be uninjured by travel over the roughest kinds of roads. The cylinders of the locomotive are seven inches in diameter, and have a stroke of twelve inches. Its total weight without water is 23,900 pounds; and when hauling a train of six loaded cars, or 10,000 feet of boards in all, is calculated to make a speed of about five miles an hour on grades less than 200 feet to the mile.



AN OUTLINE HISTORY OF THE LOCOMOTIVE ENGINE IN ENGLAND.*

By Mr. THEODORE WEST, Darlington.

OF the three grand divisions of steam power, the stationary, the locomotive, and the marine, it is scarcely possible to say which is the most wonderful, or has exercised the most widespread and beneficent influence. From the remoter times of the clearance of forest land for cultivation, and the more modern discovery of coal, a power beyond that of human labor became necessary to drain the mine and to raise and transport the mineral. From this new source of heat, through man's ingenuity, sprang the steam-engine, which, simply converting the alternate strokes of a piston into rotary movement, gave the world a new and tremendous auxiliary in utilizing all Nature's products, and ultimately revolutionizing the world of labor. From the primary step of bringing new warmth and beaming light into our dwellings, steam became the impelling power in every description of art and manufacture. By its aid in the printing-press, multiplying and diffusing all knowledge, including the Scriptures, it is intimately connected with the highest sources of wisdom and goodness; while in the modern achievements and promise of dynamic electricity, the wonderful affinities of heat, power, and light, steam itself is a mighty witness to the invisible and supernatural world around us. In steam for locomotive and marine purposes, it has another aspect of incalculable power and goodness, in lessening or overcoming the difficulties of travel by land and water, in meeting that providential arrangement by which diverse parts of the earth, climates, and races of men, produce and manipulate products which others need; by which health, comfort, social intercourse, and innocent recreation are wondrously promoted, and the dreadful sufferings of famine may be timely prevented or relieved. The gradual invention of the three branches of this mighty agent in the world's progress must always have an interest to an intelligent mind, and each of the three has a history of its own. For the first, the stationary, the genius of Watt not only developed it from the mere revolving toy, or the laboring imperfect machine, into the facile, powerful steam engine; but his high scientific knowledge and reasoning faculties enabled him as an original investigator to apply the laws of heat in the production of steam, of momentum in the fly-wheel, of centrifugal force in the governor, and, indeed, so to develop and complete the whole, that it came from his hand a docile giant with self-controlling power, a masterpiece of scientific principle and sound reasoning. While we render due honor to Leupold, Symington, and other early laborers, the stationary condensing engine is essentially Watt's invention. The early history of the marine engine is comparatively simple, and in its primary stages it links together in an interesting manner Scotland, England, and America—but that is outside our present theme.

The history of the locomotive has been a difficult and complex subject, especially to the young student whose command of books and illustrations is limited to some country town or the dead-alive libraries of his youth; because various inventors aided in its production, and either they or their descendants in later times claimed important parts of it as their own exclusive contrivance, which claims have at times been warmly contested. Books upon it have been somewhat scanty, imperfect, or anything but impartial in dealing with its history. It is easy for some of us whose practical knowledge goes back for many years to understand how the early inventors of the locomotive were often men of limited education, and too deeply engaged in the absorbing and uphill toil of making practical a hard problem, for the satisfaction of those who found the capital and the appliances for their experimenting, to give thought or time to compiling its history for posterity. Away in the bleak hills of the mining districts in Cornwall, Wales, Northumberland, Staffordshire, and Scotland, these men planned and toiled, in the crude workshops of the collieries, when the chief or only tools they had were those of the blacksmith's forge and the simplest appliances of the boiler-maker and fitter of those days, with the ardor of inventors, keenly rivaling each other for the best machinery, or to supersede and out-patent their rivals. The few early treatises on the locomotive and railways that exist are valuable in their way, but too limited or partial to furnish a full review of the subject. The more modern and costly works by Colburn and Clark are much more extensive and valuable, but scarcely complete in record or illustration, yet we gladly acknowledge our indebtedness to all these and others. They are, however, often beyond the reach of the young student, either to purchase or for reference. Smiles' *Lives of the Engineers*, like all the works of that author, are admirable as biographies, and to a very large extent as records of invention, but his life of Stephenson was primarily intended more as a biography than as a full history of the locomotive. Every man's life has a twofold character, viz., business and social. That of George Stephenson, who so greatly helped to develop the locomotive, was so excellent in his shrewdness, thrift, and ingenuity, his sturdy independence and integrity all through his eventful life, that we cannot wonder at his historian taking a rather partial view of his subject; and, while treating well the names and work of some other inventors, concentrating his praise, and exalting his favorite hero to the coveted position of the father of the locomotive. Dr. Smiles' history is in fact naturally that of an advocate for a client rather than of a disinterested judge or complete historian.

In dealing with this wide and interesting subject, we have no theory to propound, no hero to write up, still less to detract in the slightest degree from any; but having always felt puzzled or baffled by imperfect or partial histories, we conceived that the true and best way to deal with it would be patiently and impartially to gather together the illustrations we had collected during our lifetime from every attainable source into one or two sheets, and present them in a cheap and accessible form, with a brief explanation, so that, from even the schoolboy or working apprentice to the future historian, we might assist all who desired knowledge upon it to judge for themselves, from these condensed outlines, the facts of this wonderful invention. We felt the more solicitous to undertake this because we found, on visiting Messrs. Stephenson's and other engine works—where facilities were most courteously granted to us to look over old plans and documents—that of some of the earlier engines no plans can now be found, nor clear descriptions, and of others only published notes scattered in old books. We also observed with sorrow of late years how many of the older generation of engineers were fast passing away, from some of whom we might have gleaned information. Hence it seems as if it might ere long become impracticable to compile such a record, unless one soon took it in hand whose long experience and connections in the engineering world might justify him in attempting it. We found it required special care and experience in weighing evidence to enable one to distinguish engines that had borne the same names, but were by different makers and of different times. Thus, of the old familiar names, "Rocket," "Planet," "Comet," etc., there have been several of each. We now gratefully acknowledge our indebtedness to Mr. Robert Stephenson, of Newcastle fame, for his kind permission, and to Mr. Kitching and Mr. Crowe, of that firm, for their very valuable and most obliging assistance; also to Mr. Smith, of R. & W. Hawthorn's, to Messrs. George Mellor, of Derby, and W. D. Littlejohn, of Broughty Ferry, N. B., for loan of photographs of locomotives, and other kind assistance in our researches.

The Stockton and Darlington Railway, opened September 27, 1825, by the fact of its being the first public line in England, bears an important part in the early history of the locomotive, and many of its engines therefore became in a sense historical as types of invention, or deserve to be so regarded quite as much as those brought out for the famous competition on the Liverpool and Manchester line. Having for many years been engaged on the Stockton and Darlington Railway, and after it merged into the North-Eastern, and having been kindly allowed to avail ourselves of plans for this purpose, we believed that a summary of those engines might be esteemed a valuable contribution to a general history. It grew in our hands, as before mentioned, to its present form. Hoping it might prove of interest to the Cleveland Institution of Engineers to place copies among their records, the Council accepted our offer; but, as they suggested it would be more valuable if accompanied by a descriptive lecture, and, better still, if each member might be furnished with a copy of the illustrations, we now meet their wish. Our description must be brief to bring it within the limits of the proceedings.

It is noteworthy that almost all the early efforts in locomotive invention in England, Scotland, Wales, and America were for the carriage of coal. Little or no idea arose for some time of its power for passenger or general traffic. And alike in English and American experiments, difficulties arose, and the invention was seriously retarded by the very light and wretchedly laid tramways being unable to bear the weight of the engines. In the early days of mining, coal was for long carried in bags on mules or horseback; at times in carts or wagons. The roads becoming cut up, stone tracks were laid for the wheels. In 1630 heavy planks or square timber superseded stone. In 1738 tram plates were introduced; in 1786 cast-iron rails; and in 1789 an edge rail with single flanged wheels; the coned tread of the wheel was invented by James Wright, of Columbia, Pennsylvania, in 1829. The first made locomotive of which we have a record was by a M. Cugnot, in France, in 1769, for drawing artillery; it did not work well, from the pumps being defective, but this was remedied in a second engine, and it was fairly successful. Cugnot was pensioned by the French Government, and died in 1804, aged seventy-nine. A Dr. Robinson, in 1759, proposed to James Watt the idea of a steam locomotive, and in the same year Dr. Erasmus Darwin urged Matthew Bolton, Watt's partner, to construct a steam chariot. Time forbids our describing mere proposals or patents, nor can we, for the same reason, include road locomotives; otherwise they deserved a place. They doubtless, to some extent, helped forward the more useful idea of engines on rails. Watt took out a patent for a locomotive, but his description shows strikingly how his devotedness to the low-pressure condensing engine forbade his conceiving the true principle of the locomotive, viz., high pressure and rapid motion. Murdoch's engine, although only a model, has several points of merit. A steam engine on wheels, it worked successfully. Murdoch was one of Watt's assistants, and was reproved by his master for tinkering at a worthless toy. It was made at Redruth, in Cornwall, and passed into the possession of a son of the inventor. To Murdoch's genius we owe the immense boon of practical gas-lighting. Dr. Smiles states that Trevithick was a pupil of Murdoch's; a cousin named Vivian joined Murdoch in patenting a locomotive in 1802. This engine had a bellows to urge the fire, and in 1815 Trevithick took out a patent for a fanner for the same purpose; but it seems clear, from several descriptions and drawings of his early engines, that he had discovered that turning the waste steam from the cylinder into the chimney improved the draught and heating power of the boiler. Both in a letter from himself (February, 1804), and in a description by a competent observer, it is said, "The waste steam was turned into the chimney and puffed out with smoke at each stroke of the engine; when the steam was up, she went capitally well." Trevithick was an able and fertile inventor. He discovered the power of high-pressure steam, the return-flue boiler, proved the tractive power of a driving wheel on smooth rails, the use of coupled driving wheels, and did good service among the Cornish mine engines and machinery. Watt and Trevithick were keen rivals in those regions, and Watt and his partisans considered that Trevithick's ideas of high-pressure steam degraded the orthodox principle of steam working, which, in their view, could only be by condenser and vacuum, and that such pressures as Trevithick proposed were too dangerous to the public to be attempted.

In a pamphlet kindly sent to me by Mr. E. A. Cowper, a memorial edition of the life of Trevithick, there is part of Trevithick's last letter to his friend Davies Gilbert, in which he writes: "I have been branded with folly and madness for attempting what the world calls impossibilities, and even by the great engineer, the late Mr. James Watt, who said that I deserved hanging for bringing into use high-pressure steam. This, so far, has been my reward from the public. . . . . However much I may be straitened in pecuniary circumstances, the great honor of being a useful subject can never be taken from me, which, to me, far exceeds riches." Unfortunately for Trevithick, his experiments in locomotive building impoverished him; he broke off almost on the threshold of fame and success. One grievous drawback and cause of his failure with his locomotive was the constant breakage of the tram-plates. One of his high-pressure engines, erected at Tredegar Ironworks, in 1801, was still working well in 1854. It is not without reason that some have claimed for Trevithick that he was the father of the locomotive. In 1803, the first act of Parliament for a railway was granted. It was for a coal line for a private company, near Merthyr Tydvil. The first engine was tried on it on February 12, 1804, by Trevithick and Jones, of Pen-y-darran. Blenkinsop brought out an engine in 1811–12, made by Matthew Murray, of Leeds. Murray invented the double cylinder and the right-angled crank axle, the D slide-valve, and other improvements. This engine ran on four smooth wheels, but worked by a cog-wheel gearing into teeth cast on one side of the rails.

One of these engines worked for years on the Middleton Coal Railway, near Leeds. We well remember it, Leeds being our native place; and as a boy we sometimes stole a ride on the tail wagon, but the pace was so slow, and the jerks and bumps so rough that, except for the boyish pleasure of a stolen ride, walking was preferable. Another of these engines worked on the Kenton and Coxlodge coal line near Newcastle, in September, 1813; but after about a year and a half the boiler exploded. Stephenson was then living at Killingworth, and, like a prudent and skillful inventor, carefully studied this engine, as he did all others within his reach. Neither Blenkinsop nor Murray seemed to have any idea of turning the waste steam through the chimney; but from a small engraving in our possession, we infer that the waste steam was sent through a small tank to deaden the noise, and then into the open air. Two brothers, Chapman, in December, 1812, invented a locomotive to work by a chain stretched from end to end of a tramway, passed once round a grooved pulley on the engine. When the pulley revolved, it drew the engine along. In 1813, Brunton's engine with legs pushing behind was brought out. Neither of these plans passed an experimental stage. We are now in a lively era of locomotive invention, and a somewhat complex one, because of scanty records and rival claims. Wylam and its neighborhood would seem to have been a veritable school of engineering inventors. Timothy Hackworth was born at Wylam in 1786. His father before him had wrought for years in the Wylam colliery workshops. John, a son of Timothy Hackworth, claims that his father invented water tubes in boiler flues, the return flue and tubular boilers, the dome for dry steam, the water gauge in place of gauge cocks, springs to the safety valve, bearing springs and balance beams inside horizontal cylinders, and other improvements. These details of his father's inventions were kindly furnished to us by Mr. John Hackworth, of Darlington.

Mr. Blackett, the owner of Wylam Colliery, was the first coal owner in the North of England who took an interest in the locomotive. He met with Trevithick in London, inspected his engine, and determined to try one on the Wylam tramways. Trevithick was disheartened and failing, and declined to make one. Blackett then employed John Whitfield, an iron founder, of Newcastle, assisted by John Steele, who had worked for Trevithick, to make one. It proved too light for its task, and was turned into a blowing engine at the foundry. Mr. Blackett ordered a second from a Thomas Waters, of Gateshead, to be superintended by Jonathan Foster, the Wylam engine-wright. The boiler was cast iron; the engine had one cylinder, 6 in. diameter, with cog-wheel and rack rail, and weighed about 6 tons. It failed, was dismantled and sold. Mr. Blackett determined on a third, and directed his viewer, Wm. Hedley, and engine-wright Foster to build it. Hedley was born in 1779, at Newburn, near Newcastle, became viewer at Walbottle Colliery in 1801, and at Wylam in 1812. The woful Continental wars had now made horses and forage so costly that it seemed as if coal mining must be given up unless some cheaper mode of transit could be invented than the horse to one or at most two wagons on the best part of the tramway. Hedley was aware of Trevithick's experiments with the smooth wheels and rails, but now repeated them for himself. He patented his first engine in 1813. Having but two pairs of wheels, its weight frequently broke the tram plates, hence Hedley designed a second engine with the weight distributed over eight wheels. A strike occurring among the keelmen on the Tyne, Hedley placed one of his boilers and engines in a barge, applying paddles to it, thus towing the coal barges to and fro, materially helping (amid frequent showers of oaths and stones) to end the strike. Dr. Smiles states that Hedley discovered and proved the sufficiency of the smooth wheel for traction, and introduced the return flue boiler. Killingworth, where George Stephenson was now employed, was about five miles from Wylam, and Jonathan Foster being very friendly with Stephenson, often invited him to see Hedley's engine working. Some owners of land alongside the Wylam tramway complained of the nuisance of Hedley's engine, frightening cattle, etc., and questioned if the lease for the line allowed steam power to be used. Hence a case was submitted to counsel; his decision was that the lease did allow it, provided care was taken to prevent undue noise and smoke, etc. This led Hedley to turn the steam into a small tank to dull the noise, and the rest passed by a pipe into the engine chimney. Goldsworthy Gurney, in his road engine of 1828, did the same. The letter with this decision is attached to Hedley's engine now in the South Kensington Museum. We are much indebted for a just estimate of Hedley's inventive genius and energy to a small work published at Newcastle by J. M. Carr, entitled "Wm. Hedley, the Inventor of Railway Locomotion." Hedley's two engines worked for many years; one is now at South Kensington, the other at the Edinburgh Museum of Science and Art.

Robert Stephenson, the father of the famous inventor, worked at Wylam Colliery. From this pit, one of the oldest in the North of England, coals were conveyed by a tramway to the village of Lemington, about five miles down the Tyne, to be loaded into keels or barges for Newcastle, and thence into ships for London, etc. This tramway passed near in front of the house at Wylam where George Stephenson was born June 9,

* Paper read before the Cleveland Institution of Engineers, March 1, 1886.

1781. George removed to Willington in 1802, and was appointed in 1812 to Killingworth Colliery. Dr. Smiles' biography of this noted family in his "Lives of the Engineers" is so excellent that we gladly recommend those who may not have read it to do so. We are ourselves indebted to its charming history, but can here only continue our brief sketch of the locomotive. As we before noted, Stephenson, with the sagacity that characterizes a careful inventor, took every pains to acquaint himself with what others had before accomplished, and in July, 1814, he placed on the tramway his first Killingworth engine, "Blucher." In this he mainly followed Blenkinsop's engine. It had a straight flue through the boiler, and he also copied the serious defect of a wide chimney, 22 inches in diameter. On February 28, 1815, Stephenson and a Mr. Dodds took out a patent for a second engine. They adopted inside cranks and rods to couple the axles and wheels in place of chains, which were found to stretch and slip, or cog wheels, which were also noisy and objectionable. Stephenson, like Trevithick and Hedley, being threatened with an indictment for nuisance caused by his engine, turned the waste steam into the chimney.

It will be observed that none of these early engines had any smoke box, merely an uptake chimney; this, with their slow speed, scarcely allowed an effective blast pipe. Dr. Smiles states that Stephenson invented and applied the blast pipe to his No. 1 Blucher, and from that time it was a triumphant success. Stephenson's undoubted ability and perseverance led to his becoming connected with two enterprising capitalists, Messrs. T. Richardson and Edward Pease, who appointed him, in 1823, engineer to the Stockton and Darlington Railway, assisted him in founding the noted works at Newcastle in 1824; and engaged him to build the first and other succeeding locomotives for that line, which greatly owed its foundation to those gentlemen. Locomotive No. 1 is deservedly celebrated as the first locomotive built for a public railway. Its performance on the opening of the line fully realized or surpassed the highest expectations of engineer and directors. But the vital problem of the blast pipe was even yet hardly solved. We have heard Mr. Fletcher, the highly and long respected engineer to the North-Eastern Railway, tell an amusing story of his having more than once or twice seen these straight flue boilers (including this No. 1) gradually come to a standstill when at work from sheer want of steam. In awkward slippery weather, or on some long greasy incline, the speed would flag readily; the engineman, first lavishing oil on the rods and bearings, and then prizing the wheels round with a crowbar, would cry out to the fireman, "Give it to her, Bill, mon! give it to her," as Bill with his shovel strode alongside frantically scraping up small ballast and dashing it before the wheels in place of sand to make them bite (sand boxes were not then invented), but in vain—puff! p-u f-f! engine and wagons at length stood still. Thereupon ensued a passionate rousing up of the fire, a brief and rather heavy swearing match at engines generally, and this one in particular; then, hot and tired, the two men would sit down on the near railings or bank for a quiet pipe, while steam slowly rose to going pitch, then once more they mounted, and went.

Inventors always were Ishmaelites, "every man against his fellow." Matthew Wasbrough patented the crank, that Watt might not avail himself of it in his grand steam engine. Watt thereupon invented the sun and planet motion, and patented it in place of the crank. This locomotive, with Watt's sun and planet motion, was copied by permission from a well drawn plan in Messrs. Stephenson's possession, but its date and designer are unknown. The "Lancashire Witch" was by Stephenson. When made it had bellows to blow the fire, which, as Dr. Smiles remarks of Trevithick's engine, seems to show that the blast pipe principle was not yet understood. The "Lancashire Witch" is interesting, and marks a bold departure by Stephenson in the position of the cylinders, and a gradual compacting of the engine to a better form, getting rid of a host of rods and joints. The "Agenoria," by Foster, Rastrick & Co., of Stourbridge, it notable as indicating that the Tyne district was no longer the only center of locomotive enterprise. A sister engine to the "Agenoria," the "Stourbridge Lion," by the same makers, was sent to America, and was the first locomotive tried on rails in the United States. The rails there were so light that this engine could not be used. The "Agenoria" worked successfully for many years. We now arrive at another eventful era in the history, the competition of engines at Rainhill for the £500 prize offered by the directors of the Liverpool and Manchester Railway. The trial took place October 6, 1829. Four engines were entered. The "Novelty," by Braithwaite & Ericsson, failed in its blowing apparatus. The "Perseverance," by Burstal could not come up to speed, and was withdrawn. The "Sanspareil," by Timothy Hackworth, who had been a foreman under Stephenson, was disqualified as beyond the stipulated weight, and in two trials certain pipes gave way, which stopped it. Later on it did good service for a private firm, and is now in the South Kensington Museum. Stephenson's "Rocket" alone fulfilled, and even exceeded, all the conditions in both the official trials. Mr. Booth, the secretary to the Liverpool and Manchester Railway, had been over to Paris some time before this, and had either seen or known of a M. Seguin's invention of tubes and boilers. Booth suggested this idea to Stephenson, who at once saw its value and adopted it. It appears, therefore, that although Trevithick, Hedley, and Hackworth's boilers, with their return flues, were for a time in advance of Stephenson's with the straight flues, yet, as this ultimately led Stephenson to the straight multitubular plan, it gave him the mastery in the long run. The "Rocket" was the nineteenth engine built at Stephenson's works. Hackworth undoubtedly invented the blast pipe for his "Sanspareil," and some have said that Stephenson got a sight of it unfairly before this Rainhill trial, and fixed one to the "Rocket" just in time. Be this as it may, it is remarkable that Stephenson's hit the right proportions to a nicety. The blast in Hackworth's "Sanspareil," when running, was so strong that it drew a quantity of the light fuel through the tubes, and showered it from the chimney. This was pronounced by the judges at Rainhill an additional disqualification. These two grand improvements in the "Rocket," the tubular boiler and the blast pipe, gave the locomotive command of steam, and it thenceforth grew like a giant in efficiency, power, and symmetry. Before the close of the first week's running of the Liverpool and Manchester Railway, instead of thirty stage coaches there were six trains daily, and instead of 500 passengers there were 1,600. Bury's engines were light, but useful.

It would be useless to describe in detail the engines that now increased in number and efficiency. In a busy industrial nation like ours, when once a power like the locomotive was made practical it could not but grow to an enormous extent; makers in various places sprung up and vied with each other in detail and general improvement. "Invicta" was built for the Canterbury and Whitstable Railway. It was conveyed to that railway, and for some time driven by Mr. E. Fletcher, since then so long the able and highly respected locomotive engineer of the North-Eastern Railway. It was always regarded with pleasure by that gentleman, as his visit with it to that district led to his being introduced to the lady who became his wife. A Scotch engine was the first we know of with the elbow lever motion and a bogie truck, and was another link in the history, showing that the invention of the locomotive should not fairly be attributed to one individual or one district. It was developed by a number of more or less original workers, and by steady, gradual improvement, although we may allow that some excelled in the value and extent of their achievements. Here we may note in passing that the steam whistle was invented, in 1833, by William Stephens, of Dowlais Ironworks. Up to 1833 the fireman, in addition to his ordinary stoking duties, had to pull a bell or blow a trumpet for all signaling purposes. About this time Stephenson introduced his engine with leading bogie wheels. It has at times been claimed that this was the first bogie invented. Vignoles and Ericsson had one in 1830 and several American engines had it prior to 1833. The bogie having been then generally adopted in America, plans were sent to Stephenson's from which to build this engine, it being ordered for the Saratoga and Schenectady Railway. In 1833 Stephenson invented a well arranged and effective steam brake for locomotive engines. An engine by Richard Roberts, a man of considerable inventive genius, is interesting from its parallel motion and the curious position of the cylinders. Old fashioned builders of steam engines mostly had impressive ideas of the value of long strokes and long connecting rods to obviate angular strains and loss of power. This and similar short stroke engines mark a new and bold departure. The engine by T. Harrison, now the veteran chief engineer of the North-Eastern Railway, is curious as a design, but scarcely a step forward in invention. By dividing the weight of the engine and boiler, it lessened the tractive power of the wheels, which needed increasing as traffic steadily increased. But to judge fairly of this idea, it must be borne in mind that, while traffic and the needful weight of engines to haul it had been steadily growing, the strength of rails had not correspondingly grown; and it was for long an anxious question with directors whether their lines must all be relaid, or engine builders be forced to distribute the weight of their ponderous machines upon more wheels.

It was at Shepherd & Todd's, in 1840, that our engineer life began, continued at Kitson's and at E. B. Wilson's, and in wider spheres since, giving opportunities for seeing a great variety of engines, and making drawings which have greatly aided, and, as before mentioned, impelled us to put the knowledge acquired through long years into this tangible form for others' benefit. In those days it was no small advantage for a youth to be placed at a general engineering works, because not only were locomotive and stationary engines and various machines built at such works, but, before railway companies began their huge establishments, the locomotives from various lines were sent to private firms for repairs. Thus in a few years an instructive variety passed under the eyes of an observant pupil. Crampton made an engine for running high speeds with safety by lowering the center of gravity of the boiler. It would not, however, be deemed wise nowadays to sacrifice strength or integrity of boiler construction to the arrangement of the machinery. The engine by Messrs. Sharp, Roberts & Co. deserves mention for the great number of smart, effective engines turned out by that firm in a long and spirited career. Another of Crampton's patents has an intermediate crank shaft without wheels to connect the moving parts in a rather curious way. This arrangement has often been tried. Stephenson now took another bold departure. Traffic had all along been steadily increasing, and the desire was growing for high-speed trains between important and distant stations. Hence a growing necessity for fast and powerful engines. Crampton's were designed for this purpose. Stephenson, however, tried another plan. Engineers had long known that the heat from the firebox passed through the tubes and chimney far too quickly to abstract all that ought to be effective for raising steam, and hence Stephenson tried by materially increasing the length of the boiler and tubes, some to as much as 14 feet barrel, to utilize more of this wasted heat. This he patented along with placing the valves in a steam chest between the two cylinders, in 1841. The long-boiler engines were made with outside cylinders, but this outside weight and the overhanging firebox at the other end made them rock dangerously on the lines at high speeds. They disappointed the high expectations formed of them, and were mostly worked up as goods engines. Coal became generally used instead of coke in locomotives in 1854, and this change curiously marks how public feeling had changed in favor of railways, in contrast with the determined hostility shown to them in all earlier stages. Neither public opinion nor Parliament would have tolerated this change at an earlier stage. There was a wonderful variety of positions of the cylinders, and general design in the engines. A three cylinder engine by Stephenson seemed to complete and crown this variety. In it the two outside cylinders are about midway along the frame, and from the third middle cylinder the connecting rod was passed by a partition through the firebox, to the driving wheels, in the rear. It seems as if, after this curious arrangement, "the force of contrivance cannot much further go." It was a bold, original idea, and was patented, but not carried out. Stephenson also built a three cylinder engine to work express trains, and to obviate, by triple cylinders, unsteadiness on the line. The skillful counterweighting of the moving parts of the engine by balance weights in the wheels was not then generally understood or practiced. It was suggested by Richard Roberts (Sharp, Roberts & Co.) in 1839, and more fully gone into by Fernihough, 1845, and has now for years been carefully practiced. Pearson's tank engine shows one of the bulky locomotives of the Great Western broad gauge railway. Giffard's injector to replace pumps to steam boilers was invented in 1859. It was some time before it could be relied on for locomotives, on account of its not working well with hot water. This has, however, long been overcome. A four cylinder engine designed by Mr. Haswell was another attempt to balance the working parts by adding the weight and opposing forces of similar parts moving in opposite directions. A similar plan was revived in America in the Shaw locomotive in 1881. All that is attempted in these complex and expensive plans can be well attained by counterweighting the wheels. The "Lady of the Lake," similar to another rather noted engine, "Lord of the Isles," by Ramsbottom, London and North-Western Railway, was much admired at the exhibition in London in 1862. It was designed for running long distance express trains, without having even to stop to refill the tender with water. To obviate this, the tender had a very ingenious self-filling apparatus, the water scoop, which, being lowered under the tender when at full speed into a long open water trough between the rails, speedily filled the tender. A minimum speed of 22 miles an hour is required to accomplish this. The distance between London and Holyhead, 264 miles, is thus regularly run without stopping.

Fairlie's engines were first designed in connection with the Brindisi mail route to India and Australia. The Mont Cenis Tunnel was planned for accelerating the mails on that route, but as it would necessarily occupy years in construction, and there was always a steady stream of traffic between France and Italy, Mr. Fairlie warmly promoted and showed the feasibility of carrying a line, meanwhile, right over the Mont Cenis Pass, with engines constructed to grip a central rail, available, therefore, for such gradients as one in twelve and the snake-like curves that would be inevitable in a cheaply constructed temporary line over Alpine mountains. His ideas were sound, and successfully carried out in 1866. At later stages he improved his designs, and in 1870 introduced engines specially adapted to give great haulage power on railway lines in hilly districts without a mid rail, but where heavy gradients and sharp curves must be encountered. Fairlie's engines consist of two locomotive boilers joined, back to back, by one large firebox. The engine part has two cylinders to each, and a bogie or small truck frame, so that, although the total wheel base is long, these bogies enable the double engine readily to traverse curves that would be otherwise unworkable, and combine great tractive power with the weight well distributed over the rails. This manner of mounting the boilers on the frames also materially diminishes oscillation from unevenness in the lines. Many of the steepest and most difficult railway routes in mountainous countries are thus economically worked, which in the absence of this plain would be impracticable.

Strange as it may seem, railway engines appear at times to run in modes or fashions, like ladies' dresses; one invents, others improve, or try the plan; this in its turn is superseded by a novelty. Compound engines seem now the favored plan, and Joy's valve-gear, originally of Swiss invention, the mode of working and reversing the valves. Time will show whether this principle of compound cylinders will be as economically effective in the locomotive as it has undoubtedly proved in marine and stationary engines. Some leading engineers approve of it, and it will have a fair trial at their hands. For many years in the history of the colony of New South Wales, there was but one pass known in hundreds of miles, from the belt of coast land, across the Blue Mountain Range into the interior. From the level of the sea, at Sydney, to this summit the railway rises about 3,650 feet. We know the old mountain road over this pass well, having often wearily trudged it. The features of the country in which this zigzag is situated are such that the surveyors who marked out the line had to be lowered down over the rocks by ropes, and the contractors had to commence their work in the same way. From the summit, descending to the valley inland, a fall of 687 feet in 5 miles length is made. We have not felt it to be needful to describe particularly the types given of modern engines. By the steady extension of free libraries in our principal towns, by the art of photography, and the excellent engineering publications of the present day, accounts and illustrations of these are fairly accessible to those who desire to obtain them. Our object was more to rescue from oblivion some little known examples of the past, to throw light on some doubtful points, and to bring within convenient compass for reference and useful comparison the achievements of the pioneers who, under heavy disadvantages, and confronting public unbelief and discouragement, wrought out the locomotive; and whose history as a whole forms one of the finest volumes the world has known of inventive genius and heroic perseverance. And rightly to estimate the lives and works of such men, we should also steadfastly bear in mind that fine old Welsh proverb—"Failures are the pillars of success."

The secretary (Mr. Angus Macpherson) said he had received a letter from Mr. E. A. Cowper, who was unable to attend that evening, giving some interesting particulars with regard to the locomotive. The letter ran as follows:

"I am sorry that it is impossible for me to come down to hear Mr. Theodore West's paper on the locomotive engine in England, but having some time since carefully looked up all dates in reference to the subject, and myself having seen the first steam carriage (which is still in existence), I venture to trouble you with a few remarks.

"1769. In 1769 in France, one Cugnot made a steam carriage that ran out on the common road; it upset in turning a corner, close by where the Madeleine Church was afterward built, and both the inventor and engine were locked up.

"1784. In 1784 Murdoch made a little model of a steam carriage, and ran it round his own room and also on a church footpath.

"1784. Watt put the idea of a steam carriage into his patent, but discouraged Murdoch, and would not let him make a real steam carriage.

"1797. Richard Trevithick made a model of a steam carriage. He was then twenty-six years of age.

"1801. Richard Trevithick made a real steam carriage for the common road, and ran it about a

good deal, but it got considerably damaged by the hard roads in Cornwall.

"1802. Richard Trevithick took out his patent with Vivian, and made a steam carriage which he brought up to London.

"1804. Richard Trevithick made his first locomotive engine for South Wales, and it was tried upon the railroad at Merthyr Tydvil, he having made a tramway engine in 1803.

"1808. Mr. John Isaac Hawkins, whom I knew very well, saw Trevithick's locomotive running on a circular railway near Euston Square, and my father, the late Prof. Cowper, also saw it, as I have often heard him mention.

"I merely mention these early dates, as it should be generally known that locomotion on railways was accomplished very early, and certainly Richard Trevithick was the first man to succeed in England with a locomotive. He generally carried 150 lb. per square inch, though he sometimes worked at 60 lb. pressure. I do not go into the more recent dates, as the history of George Stephenson, the Wylam Colliery, 'No. 1,' etc., is all so well known."

Mr. J. M. Oubridge said: There is one thing mentioned by Mr. West I should like to refer to, and that is the engine made by Trevithick at Newcastle. It was never put on to the railway at Wylam, but I have seen it working at Gateshead. I have taken a great deal of interest in locomotives, and I have always said that Trevithick was the father of the locomotive, and that it has developed from stage to stage to its present perfection. A few weeks ago I gave an address to the members of the Engineers' Association at Newcastle, on "Personal Reminiscences of Engineers," and I spoke of Hackworth, who is deservedly referred to by Mr. West. The name of Hackworth has never been sufficiently recognized; he was an inventor, and he perfected what Stephenson originally projected. Undoubtedly Stephenson projected much in the locomotive engine, and the engine they have got at the High Level Bridge is the type of what we use now improved. The birth of the locomotive dates from Trevithick, and in Stephenson's engines we have the germ of what is now seen in perfection.

The president (Mr. A. C. Hill) said: I have been much pleased with Mr. West's paper, and the designs have brought to my recollection some of the engines of my boyhood. I remember the engines of 1830 very well. They were very good engines; I recognize a Trevithick, similar to the one described by Mr. West, used for working on an incline at Blaydon, and it had a cast iron boiler, with cylinder, in one casting. Such an engine working at high pressure would now be considered by many people a curious thing, and some of my friends have pooh-poohed the idea; I am glad Mr. West has shown that it is possible. My father was engineer at Ebbw Vale, and before the introduction of locomotives, traffic was carried on by teams, consisting of six horses each, on a single line with sidings at intervals. The directors objected to the locomotives being their competitors, and used to congregate at the watering place purposely to stop the engines. They would sometimes sit there half a day, and men good at fisticuffs had to be sent with the engines to prevent interference. By persuasion, a good supply of drink, and sometimes a good thrashing, the obstructionists were overcome, and the engines were allowed to run from Ebbw Vale to Newport and back each day. They were very good engines, made, I believe, at the Neath Abbey Railway Company's works, and I could tell their beat a mile and a half off.

Mr. Birkbeck: I have been connected with locomotive engines for a considerable time. I was at Hetton Colliery in 1848, where the "Killingworth" class of locomotive was employed in hauling the coal from the pits, and previous to this at Shildon, where Mr. T. Hackworth made his engines. I remember one of his engines, the "Arrow," which used to run the express on the Stockton and Darlington Railway, and did very well, frequently running sixty miles an hour. This engine was quite an exceptional one; it had very large cylinders, I think 21 inches diameter, and a stroke of only some 7 inches. Mr. Hackworth made a variety of engines, and scarcely two of them were alike. Stephenson, on the other hand, having got a good idea, stuck to it like a wise man, and repeated it over and over again. Hackworth did not do that.

Mr. Charles Wood: I beg to propose a vote of thanks to Mr. West for his paper this evening. Mr. West has promised us another paper before the session is out, and I need hardly remind you that in these two papers he has undertaken a task we cannot value too highly. They will form an important historical contribution to our proceedings, and for the information he has given us he deserves our warmest thanks. Mr. West referred to road locomotives. I may mention one which interested me very much when I was a boy. My father was one of the leading agriculturists of Suffolk, and he often used to carry out experiments for the Ransomes of Ipswich. Messrs. Ransome sent a road locomotive drawing a thrashing machine to his place, three or four miles out of Ipswich, every morning, and, after thrashing until night, it steamed back to the works. The locomotive had a large pair of driving wheels and a pair of cylinders underneath very much like an ordinary locomotive, and it worked exceedingly well. As experience has shown, road locomotives were not so successful with direct engines on to one pair of wheels. At the same time, the locomotive I have referred to ran backward and forward twenty times to carry out the experiments on my father's farm, and the engine worked well up to the last few years. It ran the four miles in half an hour, and it created such a sensation in going through the streets that the men in charge had often to get out of the way of a shower of stones from groups of men and boys opposed to the innovation. From that time until 1862 no agricultural locomotives came into use. In 1862 the Ransomes made a road locomotive which stuck on going up some of the hills, and it was put one side. The next successful road locomotive was brought out by Mr. Aveling, of the firm of Aveling & Porter. This had a very small pinion on the crank shaft, and a very large chain wheel on to the driving wheels. In 1860 one of Aveling's engines was sent to Moldavia, for the purpose of dragging a heavy road roller weighing something like 10 tons. The government were making new roads across the country, and the system of road-making adopted was to put down loose stones a foot deep without anything on the top. The weight of the engine sunk the wheels into the loose stones, and it was difficult to get the roller over the roads, and also exceedingly difficult to get the engine to drag the roller. I proposed to the government that they should do away with the heavy roller and make the wheels of the engine into rollers themselves. I got plates an inch and a half thick and two feet wide, and incased this road engine's wheels in a large drum. When set to work it proved a great success, and that was the first direct-acting road steam-roller ever made. I merely mention these few facts about road locomotives and rollers as I thought they would be of interest to the meeting. I propose a cordial vote of thanks to Mr. West for his paper.

The president: What has fallen from Mr. Wood is certainly very interesting, but we can scarcely consider a traction engine a locomotive. I may mention a circumstance which astonished me a little while ago. I went to Kilmarnock to look at an engine I had ordered, a four-wheel tank engine. The works were at the bottom of the town near the river, three-quarters of a mile from, and at least 40 feet below the level of the railway, and when I got there I asked to see the engine. I was informed that it had steamed up the main street, and notwithstanding its great weight there was hardly a mark in the road. We usually consider that a locomotive off the rails is an ugly thing to move about, and I was greatly astonished at the successful manner in which it was steamed up that street.

The vote of thanks was unanimously carried.

THE GAS WELL AT FINDLAY, OHIO.

To the Editor of the Scientific American:

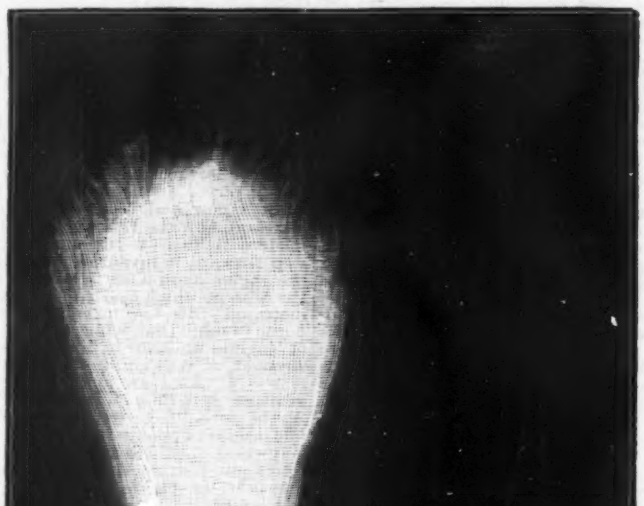
Findlay is the county seat of Hancock County, situated in the northwestern part of Ohio. At present it has a population of about 6,000. For many years there has been evidence of both oil and gas in and around the town. Old citizens tell us that about forty years ago there was a place, south of town, where gas escaped from the surface of the ground in such quantities that a small flame could be kept burning for several days at a time.

Some twenty years ago, Jacob Carr drilled a well on his lot for water to a depth of 135 feet, when he struck a small vein of gas, and the well was abandoned so far as water was concerned; but Mr. Carr turned it to account by using the gas to light and heat his house, which he continues to do to the present day. Notwithstanding all the evidences of Nature's great fuel, it would perhaps have remained undisturbed for years to come, had it not been for the untiring efforts of one man, Dr. Charles Osterlan, who for many years advocated that Findlay was situated in the center of a vast oil and gas field. For many years the old man found but few to listen to his arguments, and less to believe them; still he did not despair, and in the spring of '84 he so far succeeded in his plans that by his influence a company was formed to drill a test well, and on the 29th day of April, 1884, they took out a charter under the name of the Findlay Natural Gas Company, with a capital stock of $5,000.

This company was not composed of men of wealth, but of men of energy and preseverance, and they were considered a set of old fogies and hair-brained lunatics. Even the State Geologist ridiculed the idea of finding gas or oil in northwestern Ohio. The company commenced their first well the latter part of September, and completed it about the middle of November. At a depth of 600 feet they struck a small quantity of oil and a small vein of gas. At 1,092 feet they struck a large flow of gas, variously estimated at from 200,000 to 250,000 cubic feet in 24 hours. The well was drilled to a depth of 1,648 feet, but nothing of any importance was found below 1,092.

This was the first direct evidence of gas in this part of the State; in fact, it was argued by scientific men that this part of the State lay beyond the oil and gas limits. Soon after the drilling of the first well, other wells were drilled, and other towns began drilling. At present, Findlay has 14 wells. In drilling these wells, the following strata are found: 22 feet of drift, 245 to 417 feet of limestone, 50 feet of gray shale, 40 feet of red shale, 410 feet of gray shale, 350 feet of black shale; below this, Trenton limestone, in which the oil and gas are found. On an average, the wells are about 1,200 feet, except the first, which was drilled as a test well. In four of the 14 wells, oil was found in paying quantities. The Adams well is now producing about 25 barrels per day, besides producing 1,000,000 feet of gas. The Matthias well has very little gas, but is throwing from 40 to 50 barrels of oil daily. The Lima Street well throws from 10 to 15 barrels a day, besides producing at least 1,000,000 feet of gas.

The 13th well is known as the Karg well, and is generally called the Grandfather. It was finished on the 20th of January, 1886, and is perhaps the third well in the United States. It has been variously estimated at from 40,000,000 to 100,000,000 feet in 24 hours. The light of the well has been seen 50 miles, and the roar of the escaping gas has been heard 12 miles. Natural gas has revolutionized the town. One year ago the town paid $31.50 per post for light; now it is far better lighted with natural gas at a cost of $6.50 per post. One year ago, our citizens paid from $40 to $90 a year for their fuel; now they get their fuel and *light* for from $20 to $45 per year. We use no other light or fuel except natural gas.



THE GAS WELL AT FINDLAY, OHIO.

This clean, convenient, and low priced fuel is attracting the attention of the manufacturing interest of the entire country, and a number of iron and glass manufacturers have already decided to locate here, and others must follow.

Natural gas alone was sufficient to make Findlay one of the most prosperous and wealthy towns in Ohio; but the result of the drilling for natural gas is the discovery that the city of Findlay and surrounding country is one of the richest oil fields that has been opened for a number of years. Already the country is dotted with derricks, and practical oil men from Pennsylvania, New York, and Virginia are here, leasing all the land they can obtain.

Before a year's time there will be a hundred oil wells flowing in this country, and before two years the population and wealth of Findlay will have been doubled, and Findlay will have been changed from a quiet agricultural town to a prosperous manufacturing city.

U. K. S.

UNIVERSAL LACQUER.

WHICH is equally good for paper, metal, wood, glass, etc., and which admits of being colored with any aniline dye soluble in alcohol, is, according to *Oel und Fett Industrie*, prepared as follows:

Bleached shellac, 60 g.; Manila copal (freshly powdered), 60 g.; and gum mastic, 60 g., are mixed with 1 kg. of alcohol of 92 to 95 per cent., a small quantity of coarsely powdered glass added, and the whole left to stand for eight to fourteen days, frequently shaken; 1 g. of boracic acid is then added, and the mixture filtered.—*Ph. Post in Chemist and Druggist.*

HYDROPHOBIA AND CEDRON SEED.

To the Editor of the Scientific American:

In your issue of January 16 appears an article under the caption of "Hydrophobia can be cured" from the pen of Mr. Thomas Pray, wherein he asserts the long since exploded virtues of the *Simaba cedron*, besides embodying many statements that, if uncontradicted, might tend to harm. I do not question his honesty or sincerity of purpose, but he has been misled, as is often the case, accepting coincidences as facts, and but pays the penalty that accrues to the laity, who strive to enter the domain of science without proper preparation and knowledge.

Let me remark that less than five per cent. of the cases claimed as hydrophobia, *even in animals*, are really *rabies*, the error being of ignorance, and mistaking a *symptom* of many diseases as specific of one! Second, no *remedy*, in any sense of the word, has ever been discovered for either rabies or serpent poisoning, an antidote being a physiological impossibility in the latter instance, while in the former the disease never manifests itself with sufficient constancy to admit of such a suggestion (see article on Serpent Poisoning in SCIENTIFIC AMERICAN SUPPLEMENT, No. 421). Third, the poison of rabies and of venomous serpents present diametrically opposed physiological phenomena, hence one remedy cannot be equally applicable!

As regards the *Simaba cedron*, possessing a knowledge of it extending over years, and through prolonged residence in countries that are its habitat, I assert, without fear of successful contradiction, that it is in no way or sense a remedy for any form of poisoning save as any bitter tonic may be. That it is lauded by natives as a remedy for fevers and serpent bites is very true, as is every *bitter*, all requiring the same mode of administration, of which more anon. Neither is the cedron a new remedy, as Mr. Pray supposes; but its virtues were advanced and exploded more than a quarter of a century gone by. It was introduced to the notice of the medical profession of Europe and America as early as 1846. Herran, Carrientre, and other French writers treat of it exhaustively in *Annales de Therapeutique* of 1851, 1852, and 1853. *The American Journal of Medical Sciences* for 1851, *Medical Times* and *U. S. Dispensatory* of 1852, and the *New York Journal of Medicine* for 1854, all discuss its claims. In *Practical Therapeutics* for 1866, Dr. Waring says, remarking upon the varied and extravagant claims for the drug and its repute as an antidote to snake bite and *rabies*: "The mode of administration by the natives is to give grs. ij–v of the seed *in a large glass of spirits!*" which is perfectly in accord with Mr. Pray, though it is cited merely as *hearsay* evidence, since disapproved by the author. Of like value in therapeutics is the evidence of a Dr. Glonigen, in Philadelphia, who discovered *lupuline* (the active principle of the hop, and a little less bulky than *bran*) to be a specific for "*delirium tremens*" in doses of six pounds; subsequent investigation revealed he administered it in form of *tincture* made with *six pints of brandy!*

Simaba cedron is in no sense an arterial excitant or stimulant, save as any remedy, even the most simple, may be incidentally. It is simply a bitter tonic of like rank with *quassia*, depending upon the same active principle, or *quassine* (also denominated *cedrine* and *cedronine*), for its virtues. It has merely run the same gantlet as a specific for poisons of animal origin as such other inert remedies as boneset, snake root, button root, black cohosh, fig weed, jewel wort, flea wort, plantain, and skull cap, all of which derived their reputation from aboriginal sources. To-day, among the Cherokees, the common nettle is a greatly vaunted specific, as is the orayuri bark among the Mayas of Southern Mexico and Yucatan!

One word with regard to Dr. Buisson, who is a self-convicted liar and charlatan. His testimony rests solely upon an article in the *Salut Publique de Lyons* (a secular publication), in which it appears as an *advertisement*. First he claims to have met and cured *four hundred cases of rabies*, which will require considerably more than the customary *grain of salt* to digest. Second, he proves himself to have been the victim, not of *rabies*, but of *acute nervous hyperæsthesia* induced by fright, as he accounts for his inoculation as follows: "In attending a female patient in the final stages of canine madness, I imprudently wiped my hand with a handkerchief impregnated with her saliva!" Save in imagination, he was never exposed to rabietic virus, for there is not the slightest evidence in support of the vulgar conjecture that the saliva of the rabietic human being is capable of transmitting the disorder. On the contrary, such transmission is with good reason supposed to be restricted to the true carnivora. It was his inability to secure virus from non-carnivorous creatures that led Pasteur (of whom and his method I have something to say on another occasion) to seek the poison in remote portions of the animal economy—brain and spinal cord!

G. ARCHIE STOCKWELL, M.D., F.Z.S.

Port Huron, Michigan.

TREATMENT OF CARBUNCLE WITHOUT INCISION.

IN a recent issue of *Daniel's Texas Medical Journal*, Dr. C. H. Wilkinson, of Galveston, gives the result of his experience in the treatment of carbuncles with injections of carbolic acid during the last six or eight years:

An Italian laborer, æt. 51, applied to me for treatment of a well-developed carbuncle, situated upon the posterior cervical region, which measured five by six inches, and was very irritable. I selected two or three of the most prominent sinuses, and injected into each of them about ten minims of pure carbolic acid, full strength. On the second day after the injection, it was noticed that the inflamed areola had nearly disappeared, and the sore itself was casting off several large sloughs. A few more drops of acid were then injected, after which the ill-conditioned, painful, and highly inflamed carbuncle was converted into a simple, healthy, granulating ulcer, which healed to complete recovery within a few weeks after.

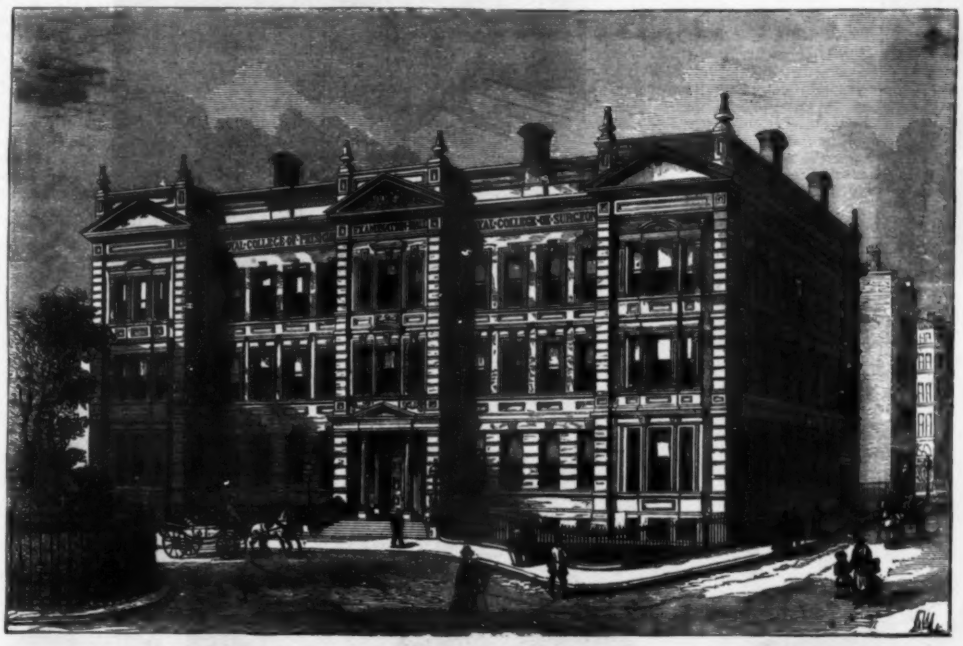
Since the treatment of this patient I have fallen heir to many similar cases; the carbuncle in the great majority of instances being situated on the nucha; and in every instance did a speedy return to health follow the carbolic acid treatment, as carried out in the case of the Italian. My method of employing the agent has been, as just stated, to select a few prominent sinuses and inject into them from five to ten drops of pure liquid carbolic acid, using an ordinary hypodermic or, better still, a Heaton's hernia syringe, throwing the fluid in the direction of the hard, red, and painful spots about the periphery, and being careful to pick up all excess of acid that might ooze back through neighboring sinuses, with sponge or blotting paper.

Carbolic acid, in this class of cases, acts by converting an unhealthy into a healthy inflammation. All erysipelatous tendency is checked instanter, wherever the acid touches, while the stimulus it affords to the capillaries promotes absorption on the one hand and healthy granulation on the other. Great sloughs of necrotic, connective tissue are thrown off, and the carbuncle is soon converted into a rapidly healing simple ulcer.

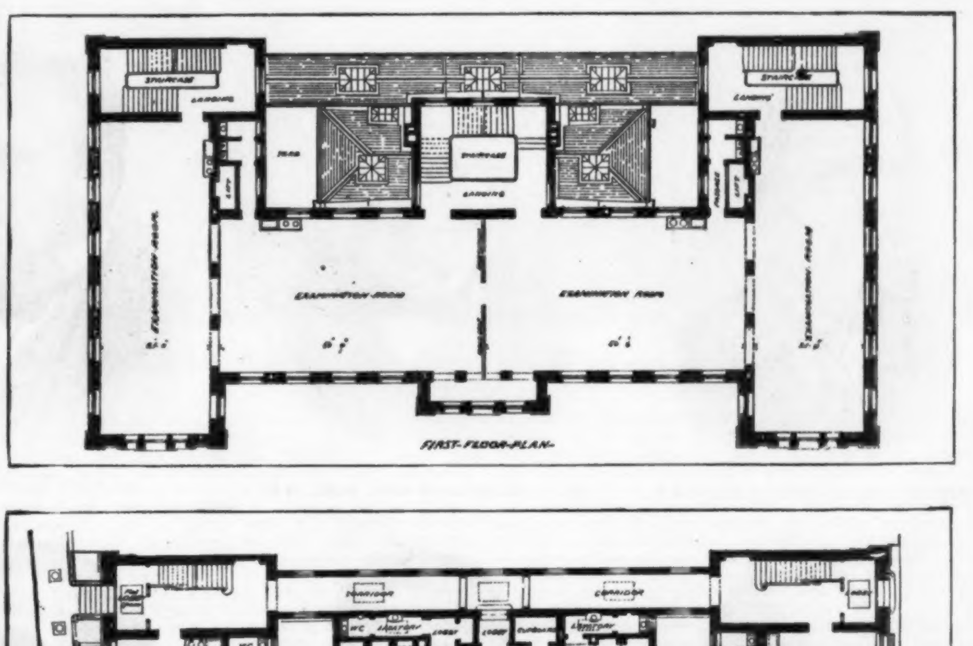
Furthermore, carbolic acid acts as a local anæsthetic in these cases, and did it do no other good than this in these most painful affections, we would be amply justified in its employment for this purpose alone.

NEW EXAMINATION HALL FOR THE ROYAL COLLEGES OF PHYSICIANS AND SURGEONS, LONDON.

ON the 24th of March the Queen laid the foundation stone of this new building, which we illustrate. The structure will occupy a prominent site on the Thames embankment at the foot of the Savoy, between Savoy street and Savoy hill, on land belonging to the Duchy of Lancaster, a few yards west of Waterloo bridge. The building, which has but little pretensions to architecture, will cost over £29,000, and Messrs. Higgs & Hill are the contractors. The frontage measures 150 ft., and, with the basement, will contain five floors. The ground floor will be occupied by offices for clerks and smaller examination rooms, with private apartments for the examiners. The first and second floors are identical in plan, each comprising a large examination hall, 100 ft. by 30 ft., capable of division into two apartments. An apartment for chemical examinations will be provided on the third story, and here also will be rooms for anatomical purposes. The materials used in the facades are to be red brick and Portland stone dressings, treated in a sort of Italian style, without much interest. The facing bricks are those known in the trade as "T. L. B.s," and are supplied by Messrs. Thomas Lawrence & Son, of Bracknell. Mr. Stephen Salter, F.R.I.B.A., is the architect.—*Building News.*



THE NEW EXAMINATION HALL OF MEDICINE AND SURGERY, LONDON.



THE NEW EXAMINATION HALL OF MEDICINE AND SURGERY, LONDON.

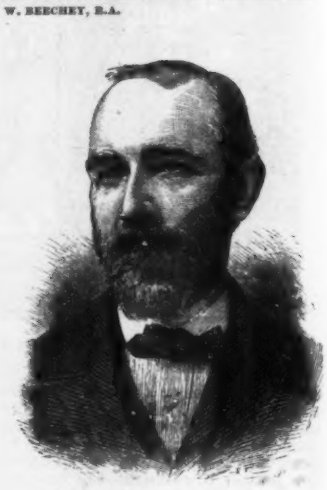
THOMAS LINACRE, M.D., FIRST PREST OF THE ROYAL COLLEGE OF PHYSICIANS.
FROM THE PICTURE AT WINDSOR, BY HOLBEIN.

SIR EVERARD HOME, FIRST PREST. OF THE ROYAL COLLEGE OF SURGEONS.
FROM THE PICTURE BY SIR W. BEECHEY, R.A.

MR. W. S. SAVORY, M.B., F.R.S.,
PREST. OF THE ROYAL COLLEGE OF SURGEONS.

SIR W. JENNER, BART, K.C.B., M.D., F.R.S.,
PREST. OF THE ROYAL COLLEGE OF PHYSICIANS.

SIR H. A. PITMAN, KT.,
REGISTRAR OF THE ROYAL COLLEGE OF PHYSICIANS



DR. DYCE DUCKWORTH, M.D.,
TREAS. OF THE ROYAL COLLEGE OF PHYSICIANS.

SIR JAS. PAGET, BART., D.C.L., F.R.S.

SIR T. SPENCER WELLS, BART, M D.

MR. JOHN WOOD, F.R.S.,
SENIOR VICE-PREST. OF THE ROYAL COLLEGE OF SURGEONS.

DR. W. M. ORD, M.D.

MR. EDWARD LUND, F.R.C.S.

DR. E. H. SIEVEKING, M.D.

MR. HENRY POWER, M.B.,
VICE-PREST. OF THE ROYAL COLLEGE OF SURGEONS.

MR. JOHN MARSHALL, F.R.S., LL.D.

MEMBERS OF THE ROYAL COLLEGE OF PHYSICIANS AND THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

MEMBERS OF THE ROYAL COLLEGES OF PHYSICIANS AND SURGEONS.

THE Royal College of Physicians of London, now inhabiting a well-known edifice at the corner of Trafalgar Square and Pall Mall, East, was established so long ago as 1523, under a statute confirming King Henry VIII.'s charter of 1518. Its founder was Dr. Thomas Linacre, born in 1460, who had been physician at the Court both of Henry VII. and Henry VIII., also tutor to Prince Arthur, and had taken orders as a clergyman. Linacre was himself the first President of the College, which met at his house in Knightrider Street Thence it moved to Amen Corner, where Harvey gave his famous lectures on the circulation of the blood.

The Royal College of Surgeons occupies a building equally well known, on the south side of Lincoln's Inn Fields.

The first President was Sir Everard Home, M.D., Professor of Anatomy and Surgery, who had studied under John Hunter, his brother in law, and practiced in London nearly forty years. He was Sergeant-Surgeon to King George IV., who made him a baronet; and he died in 1832. A Surgeons' College had existed, however, for more than a century previously, being carried on at Barber-Surgeons' Hall, on the site of the present Central Criminal Court in the Old Bailey. It was here that the bodies of the numerous criminals hanged at Tyburn were dissected for the promotion of a knowledge of anatomy. The present hall was designed by Barry in 1834, and was opened two years later. Its front presents a lofty portico, with fluted columns, above which is a bold entablature along the upper part of the building, with a decorative cornice. The most interesting part of the interior is the museum, a suite of three spacious rooms, with galleries, containing a very complete collection, originally that of John Hunter, illustrating the vital organs of animals and their functions, and the effects of their diseases; the skeletons of human beings remarkably formed or of uncommon stature, and that of Chunee, the famous elephant of Exeter Change, may also be seen there. The library and the council room of the Royal College of Surgeons contain portraits of eminent men of that profession; there is a fine marble statue of John Hunter and a cartoon of Holbein's great picture at the Hall of the Barbers' Company in Monkwell Street, representing King Henry VIII. giving the Charter to the "Barber-Surgeons."

The increasing number of students presenting themselves at the Royal Colleges of Physicians and Surgeons has long exceeded the accommodation at the disposal of those learned bodies. The uniting of the places of examination is convenient; and, as the opportunity is being taken advantage of to add another fine building to the metropolis, the public, as well as the colleges and the students, will gain an advantage.

The site secured for "Examination Hall," as the new building is to be called, is immediately west of Waterloo Bridge, between Savoy Street and Savoy Hill, and the main front abuts on the Embankment gardens, commanding an extensive view, and providing ample opportunities for the façade being seen to great advantage. The architect is Mr. Stephen Slater, of Woburn Place.

We present, upon this interesting occasion, the portraits of some of the most eminent members, at this day, of the two professions, belonging to the Royal College of Physicians and the Royal College of Surgeons of England.

Sir William Jenner, Bart., K.C.B., M.D., was born at Chatham in 1815, and was educated at University College, London.

He is the author of medical treatises of high repute, dealing especially with fever, diphtheria, diseases of the heart and lungs, acute specific diseases, and diseases of children. In 1881 Sir William Jenner was elected President of the Royal College of Physicians, and has since been re-elected.

Sir Andrew Clark, Bart., M.D., is a Scotchman, born in 1826, and educated at the universities of Aberdeen and Edinburgh. The Queen in 1883 raised him to the rank of a baronet, in recognition of his professional merits. He is author of many special treatises, chiefly relating to diseases of the respiratory and of the digestive organs, and of contributions to the medical journals.

Sir William Withey Gull, Bart., M.D., was born in 1816, at Thorpe-le-Soken, in Essex. He was called in to attend the Prince of Wales in the perilous malady of his Royal Highness (typhoid fever) at the end of 1871; and was created a baronet, and appointed one of the Queen's physicians extraordinary, in acknowledgment of that service.

Sir James Paget, Bart., F.R.S., was born at Yarmouth in 1814, became a member of the Royal College of Surgeons in 1836, and an honorary Fellow in 1843; he is one of the Council, and was elected President in 1875. He is consulting surgeon to St. Bartholomew's Hospital, and Sergeant-Surgeon Extraordinary to the Queen, who, in 1871, conferred a baronetcy upon him; he is also surgeon to the Prince of Wales. He has contributed largely to the Transactions of the Royal Society and of other learned societies, and is the author of the Pathological Catalogue of the Museum of the Royal College of Surgeons, of several series of published lectures on surgical pathology, and of a treatise on the use of the microscope in surgical cases.

Sir Thomas Spencer Wells, Bart., M.D., was born in 1818, at St. Albans. He is surgeon to the Queen's household; and in April, 1883, her Majesty created him a baronet, in recognition of "the distinguished services which he has rendered to the medical profession and to humanity."

Sir Henry Alfred Pitman, Kt., M.D., was born in 1808, educated at Trinity College, Cambridge, and has been nearly fifty years a member of the Royal College of Physicians, in which he holds the office of Registrar; the knighthood was conferred upon him in 1883.

HENRY VIII. PRESENTING A CHARTER TO THE COLLEGE OF SURGEONS.—FROM THE PICTURE BY HOLBEIN, IN BARBER-SURGEONS' HALL.

REMARKS ON THE AERATION OF WATER.*

By CHARLES B. BRUSH, C.E.

THE following statement relates to the process for the aeration of water as introduced during the past year on the works of the Hackensack Water Company, and as now being introduced in the city of Philadelphia. The Hackensack Water Company, reorganized, supplies that portion of New Jersey on the west bank of the Hudson River lying opposite that portion of the city of New York above Grand Street, and including Hoboken, Union Hill, Weehawken, North Bergen, Ridgefield, Hackensack, and other adjacent places.

The water is taken from the Hackensack River at New Milford, about five miles above Hackensack; from thence it is pumped 14 miles through a cast-iron main to the principal reservoir on the heights north of Hoboken. The Hackensack Reservoir is connected with this main about three miles from the pumping station.

During June, 1884, an unpleasant taste and smell was first noticed in the water furnished to Hoboken; in July these peculiarities became very pronounced, and then a green scum began to collect on the water in the Hoboken Reservoir. After a while this took the appearance of green paint. The reservoirs were full in anticipation of the summer drought. There was no unpleasant taste or smell from the water drawn along the force main; none from the water in the river; none in the water supplied to Hackensack; and none in the Hackensack Reservoir; but after the water was delivered into the Hoboken Reservoir, the taste and smell became offensive. As soon as this green scum appeared on the surface of the water in the Hoboken Reservoir, the water in that reservoir was cut off from the city, and Hoboken was supplied directly from the pumps.

I found that by keeping the water in motion from the time it left the river until it was delivered to consumers in Hoboken, the unpleasant taste and smell largely disappeared. The assistance of Dr. Leeds, of Stevens Institute, was then obtained. We found that this green scum continued to increase on the surface of the water in the reservoir until a white scum appeared in the middle of it, with a further development of bluish streaks and a foam-like appearance, culminating finally in white patches over much of the bluish-green surface.

This remarkable appearance was confined to the surface, the water two feet below not being visibly affected. When the wind sprang up, this discoloration disappeared. Analyses, frequently made, showed that there was a deficient supply of oxygen in the water, and that this development of green *algæ* increased as the supply of oxygen in solution in the water decreased. In its normal condition the amount of oxygen in solution in good water is about 6¼ cubic centimeters per liter, 0·65 of 1 per cent. by volume, but in this case it had run down to about 3½ cubic centimeters. The drainage area of the works is about 100 square miles. There is no sewage pollution in this area. The difficulty was entirely of vegetable origin.

Since the deficiency in oxygen, together with a somewhat large percentage of dissolved extractive matters of vegetable origin, were the only abnormal features revealed by chemical analysis, Dr. Leeds suggested that we could improve the water by supplying the oxygen requisite to bring the water to its normal condition, and probably succeed in oxidizing the dissolved extractive matters at the same time.

He had found by laboratory experiment that he could cause the offensive taste and smell which affected the Philadelphia water supply as taken from the Schuylkill River in January, 1883, to entirely disappear, and had been led to devise a process by which aeration could be easily applied. The benefit of aeration of potable water has indeed been recognized from time immemorial, and had already been made the subject of certain patents in this country by Mr. R. D'Heureuse, but these involved the use of air at merely ordinary atmospheric pressure.

Dr. Leeds controls these patents, but has improved upon them by introducing the air under greater pressure, which not only causes the work of oxidation to be very rapidly and effectually performed, but makes the process of such a character as to be easily applied in practice. Under his advice we set up air compressors

* From Transactions American Society of Civil Engineers. Read at the Annual Convention, June 26, 1885.

at New Milford, and forced air into the mains under a pressure of about 125 pounds to the square inch.

By so doing, the oxygen in the water is increased, and, ordinarily, when the water is not turbid from suspended earthy matter (a difficulty encountered after heavy storms, and which, of course, can only be completely removed by filtration), it manifests a sparkling appearance, and has only a pleasant taste and smell. The water as drawn from the main is often perfectly white, but in a moment it clears up from the bottom like soda water, and those who take the water directly from the main drink it with delight while still effervescent. We commenced in September, 1884, with this aeration process. We had no difficulty during the fall, and expected none; but during the winter there was a taste and smell in the water which was supplied to Hackensack. There was some forty or fifty days' supply in the reservoir of that town, which was covered with ice two or three feet thick, and all the streams that supplied our pumping station were covered with ice.

In order to test the aeration theory, we pumped air directly into the distribution main at Hackensack; within six hours the smell and taste had disappeared from the water in these mains. Then we cut the ice and pumped air into the water in the reservoir, after which the difficulty there also disappeared. On May 30, 1885, the smell and taste again appeared in the water supplied to Hoboken.

We were partially aerating the water at the time; we increased the amount of air supplied, and the smell and taste entirely disappeared. At present the condition of the water seems to be excellent. We are, it is true, just entering our dangerous season. Perhaps the aeration process will not carry us through, but we believe it will. We are careful to keep the water in our reservoirs so moving that every part shall be supplied with aerated water. We also keep the reservoirs properly stocked with fish, principally carp and black bass, removing them as they become too numerous.

Analyses of the water from different points are made once a month, and sometimes oftener. Microscopic examinations are made also, which show that the animal life is changed in different conditions of the water.

THE ROTARY PUNKAH.

THE present form of the propeller is eminently adapted for use in tropical climates and on passenger

vessels plying in tropical seas, and in fact in all cases where it is desirable to have a highly efficient ventilator capable of being worked by hand.

As is well known, the action of the ordinary punkah is merely such as to set up a violent agitation of the air without in any way tending to expel the foul air, or supply its place with an incoming column of fresh air; with the invention now before us this is not the case, as it absolutely moves the air with which it deals from one place to another in any desired direction.

As will be seen from our illustration, the "rotary punkah" is a light pattern propeller mounted on an ingeniously and strongly constructed stand, consisting of three pieces of iron gas-pipe attached at their lower extremities to a triangular wooden base, mounted on casters, to insure the portability of the whole. Even with a propeller of this size, easily driven by a man, the whole atmosphere of a room 25 ft. by 20 ft. by 10 ft. may be changed every minute; and in case of blowing the air into the room it can, if desired, be moistened at pleasure by contact with wet surfaces.

By availing himself of the multiplying gear shown in the figure, the manager of the company, Mr. M. Shillito, has still further improved the propeller; and as with this arrangement one revolution of the handle gives two of the wheel, it is easy for a man with a 48 in. propeller to either propel or remove over 5,000 cubic feet of air per minute.

The whole apparatus, which can be readily taken to pieces and packed in a box for shipment, weighs under a hundredweight, and is strongly made and not liable to get out of order.

This form of ventilator would doubtless prove itself very useful on board ship, from the fact that it can be brought to bear at any point at a moment's notice without in any way interfering with existing arrangements, and is readily stowed away when not required.

It should also supply the want, now felt in many hospitals, of a convenient apparatus for changing the air in the wards.

The Blackman Air Propeller Ventilating Company, of No. 57 Fore Street, E. C., London, are the manufacturers.

APPARATUS FOR PREPARING GELATINE ARGENTIC-BROMIDE EMULSIONS AND FOR COATING AND DRYING PLATES.

By HENRY LONDON.

THE formulas, apparatus, and mode of working which will be hereafter described are those which experience has found to be useful and practical. Any person, by following these directions, may succeed in making for himself excellent rapid dry plates.

As a general rule, I prepare the emulsion in the evening, and the formula to be given should make 22 oz. of finished emulsion, with which fifty-four 6½ × 8½ glass plates may be coated.

PREPARING THE EMULSION.

I have adopted the French weights and measures. The emulsion should be mixed by a non-actinic light; that which I employ is in the form of a good-sized lantern, 6 inches square by 10 inches high, having inside a kerosene lamp with a long chimney. The front and sides are glazed with one thickness of ruby glass, the front pane being covered with one, and the side panes with two thicknesses of yellow orange post-office paper. When preparing the emulsion, or coating plates, the light is turned up only to half its full height. The lantern is fixed on a shelf one foot above the table and about three feet from the place of mixing or coating (see Fig. 8).

First make the following two solutions:

No. 1.

Bromide of potassium	20 grammes.
Gelatine, Nelson's No. 1	3 grammes.
Iodide of potassium	4 grains.
Distilled water	170 c. c.
Alcohol, 95 per cent	25 c. c.

No. 2.

Nitrate of silver	25 grammes.
Distilled water	170 c. c.

On the following evening make as follows:

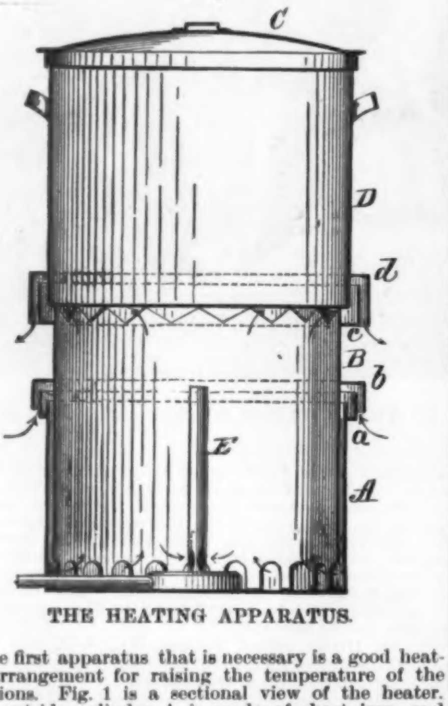
No. 3.

Heinrichs' special gelatine	34 grammes.
Nelson's No. 1 gelatine	4 grammes.
Distilled water	180 c. c.

Each of the above solutions may be prepared separately, in ordinary light. Solution No. 1 is placed in a water bath of warm water, and constantly stirred with a glass rod; when all the ingredients are completely dissolved, it is tested with blue litmus paper for acidity; if not acid, it is made so by the addition of enough of the following to turn the litmus slightly red:

Distilled water	5 drachms.
Acetic acid	1 drachm.

Fig. 1.



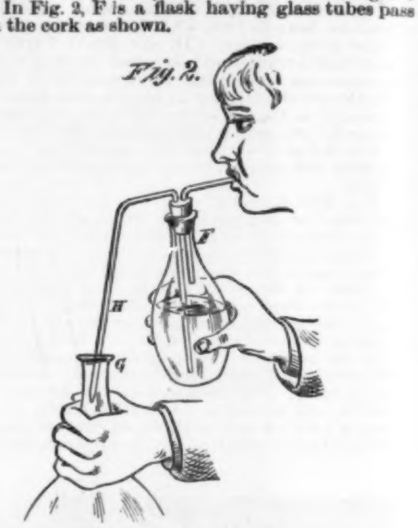
THE HEATING APPARATUS.

The first apparatus that is necessary is a good heating arrangement for raising the temperature of the solutions. Fig. 1 is a sectional view of the heater. The outside cylinder, A, is made of sheet iron, and riveted at its upper end is an upwardly projecting air inlet flange, *a*.

Setting inside the outside cylinder, A, with its upper and lower edges escalloped or serrated, is an inside cylinder, B. A downwardly projecting air inlet flange, *b*, is riveted to the outside of cylinder, so that it projects just over the flange, *a*, on cylinder, A, as shown. A second upwardly projecting inlet flange, *c*, is riveted to the upper end of cylinder. Resting on the upper edge of the cylinder, B, is an ordinary metal boiler, D, having a downward projecting inlet flange, *d*, at the bottom, which overlaps the flange, *c*, on the cylinder, B. The cover of the boiler has projecting flanges, making a light-tight joint when placed in position.

Inside of the cylinder, B, is put a Bunsen gas burner, E, or kerosene lamp, a close joint being made where the supply tube passes through the outside cylinder, A. It will be seen that the above construction permits of the burning of the gas or lamp in a dark room without danger of the light escaping. All of the projecting flanges must be blackened on the inside. In place of the boiler, D, a smaller and more shallow boiler may be put on, to be used as a hot water bath, which will be found necessary to keep some of the solutions at a uniform temperature. The air to supply the burner, E, passes between flanges *a* and *b*, down between cylinders A and B, through apertures at the bottom of the latter, as shown by the arrows, while the heat escapes at the top of cylinder B, between flanges *c* and *d*. In Fig. 2, F is a flask having glass tubes pass through the cork as shown.

Fig. 2.



MIXING THE SOLUTIONS.

Three quarts of cold water are put into the boiler, D, Fig. 1, which should be at the boiling point by the time solutions Nos. 1 and 2 are prepared. The boiler is next removed, and in its place is put the smaller boiler or water bath. In a 10 oz. glass beaker is placed solution No. 1, and in the flask, F, Fig. 2, solution No. 2, the cork and tubes having been removed. The beaker and flask are next placed in the shallow water bath, and enough cold and hot water from the boiler is poured into the bath to surround them without danger of floating or upsetting, the temperature of the water being no higher than 110° F. From the lamp underneath, the temperature of the surrounding water is gradually raised until, by a liquid thermometer immersed in solution No. 1 in the beaker, a temperature of 155° is indicated.

The whole apparatus and operations should now be transferred to the dark room.

The water bath, with the beaker and flask in it, is now removed from the heater and set upon a table, the boiler previously removed is again returned to the heater, and the water in it left to boil, while the following is being done:

The cork and bent glass tubes are inserted in the flask, F, then the No. 1 solution is poured from the beaker into a second 24 oz. flask, G, and in it is inserted the pipette tube, H, of flask F. Holding flask G by the neck in the left hand, Fig. 2, the operator by blowing through the tube forces the silver solution in a fine stream into the bromide solution until the flask is emptied. The flask G is continually rotated, by the left hand, while the flask, F, is steadied in a water bath by the right hand. The constant agitation of the No. 1 solution in flask, G, is necessary during the injection of the silver solution, in order that the silver may be completely converted into bromide of silver. The cork and tubing are next removed from flask F, and the latter is rinsed with 20 c. c. of distilled water, which is added to the mixed emulsion in the flask, G. A piece of clean cloth is tied over the mouth of the latter, and it is then placed in the boiler, the water in which is at the boiling point. The cloth over the mouth of the flask prevents the water of condensation in the boiler from dropping into the flask. The cover, C, Fig. 1, of the boiler is now put on and the flask left in for twenty minutes, the cover being removed every six or seven minutes, so the flask may be shaken each time for twenty to thirty seconds during the twenty minutes the emulsion has to boil.

The flask is next removed from the boiler, and the emulsion poured from it into a quart stone bottle (an ordinary stone porter bottle will answer); the flask is immediately rinsed with 20 c. c. of distilled warm water, and the latter added to the emulsion in the stone bottle. The bottle is corked and put under a stream of cool water until the temperature of the emulsion is reduced to 85° or 90° F., but it must not exceed 90°.

After the emulsion has cooled down to 85° or 90° F., the bottle is removed and the following solution—

Alcohol (nearly 2 drachms)	5 c. c.
Ammonia (sp. gr. 910)	105 minims.

is added, a little at a time, vigorously stirred, the bottle being shaken up after each addition.

The water in the boiler, D, must not now be warmer than 100° F., and after putting in the bottle, which must be nearly covered with the water, the gas flame should be turned down low.

It will now be necessary to tie the cork down, else it will be liable to be forced out, thereby damaging the emulsion, for we may now remove the lamp from the lantern and work by a strong light. The bottle is now replaced in the boiler, D, the water in which must be kept at a temperature of 100° F., and the bottle allowed to remain there thirty minutes. The light below is next extinguished and the bottle kept in the boiler till the next morning. It is then removed and vigorously shaken for two or three minutes. This should be repeated seven or eight times for a period of twelve hours.

During the day, while away from home, I generally have some one at home do the shaking. Returning in the evening, I prepare No. 3 solution in a 12 oz. glass beaker, setting it into a water bath at a temperature of 125° F., and while preparing the above and dissolving it, the bottle of emulsion is also set into another water bath, at a temperature of 90° F. When No. 3 solution is dissolved, it is cooled down to 100° F., and added,

two ounces at a time, to the warm emulsion in the stone bottle, the latter being well shaken after each addition. This must be done by ruby light.

As soon as all of No. 3 has been added, the bottle is well shaken and the emulsion poured into a two pound gallipot (an article which can be obtained from almost any druggist); the cover is put on and it is left standing for ten hours, or until the next morning, when it will have solidified into the form of a jelly. To remove it from the pot I pour in upon the jelly a few ounces of water; then with a glass rod I loosen the cake of jelly from the inside by running the rod around between the jelly and the interior surface of the pot. When the pot is turned over, the emulsion jelly comes out in one cake and falls into the well, I, of the squeezing press, Fig. 3, falling on a silver plated copper wire net, J, at the bottom (see the full size of the meshes in Fig. 5).

Fig. 3.

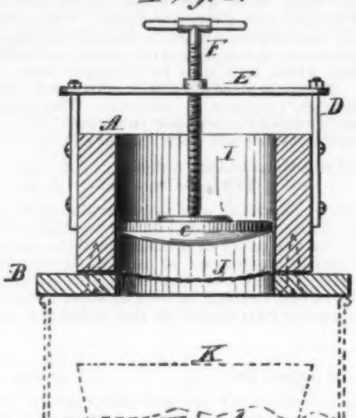
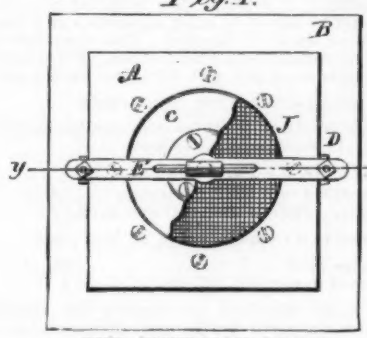
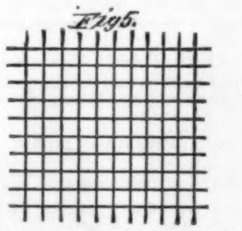


Fig. 4.



THE EMULSION PRESS.

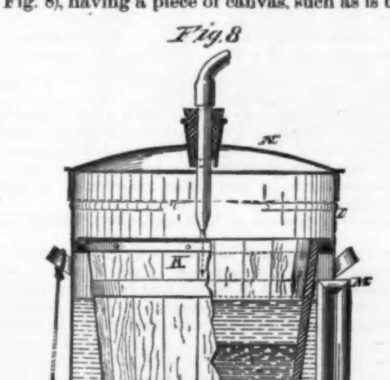
Fig. 5.



SILVERED COPPER WIRE BOTTOM—FULL SIZE

By means of this press the emulsion is forced through the netting into the washing wood bucket, K, below (see Fig. 8), having a piece of canvas, such as is used by

Fig. 8



WASHING THE EMULSION.

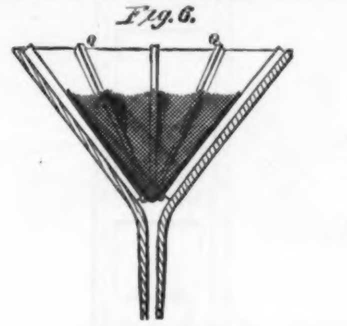
ladies in making or working worsted work, tied over the open bottom. The bucket is supported by flanges on the interior of the washing box, L, Fig. 8, and in one side of the latter is a siphon tube, M. The strata of emulsion seen in the bottom of the bucket, K, is washed for an hour or more by allowing the water to enter from above in a gentle stream, about as fast as the siphon draws it off. By stopping the inflow, the siphon will drain out all the water. The cover, N, of the washing box has a conical-shaped aperture in the top for the rubber cork holding the inlet tube; when this tube and cork are withdrawn, the extra cork, O, hanging by a string at the side, is put in. P is a sink placed near the table for carrying off the waste water. The washed emulsion should now be tested for fog, which is done by taking two 3 oz. beakers, putting into one 1 oz. of developer prepared for developing a plate, and in the other 1 oz. of water.

With a silver spoon, a small quantity of the washed emulsion is taken from the bucket, K, and dropped into each of the beakers. If it is a pyro developer, it is allowed to stand for two minutes; if ferrous oxalate, five minutes; then the developer is thrown off and the emulsion rinsed in three changes of distilled water, and both samples, the one that had the developer on and the one without, are taken as soon as possible to daylight and compared; if this is not done promptly, they will change color very quickly. If the emulsion that had the developer on does not look in any way blackish, or show any change, it proves that it is perfect and will do to coat plates with. If, on the other hand, there is a perceptible difference in color between the two, it will be a sure sign that the emulsion is defective, and the quickest way to dispose of it will be to throw it into the waste and prepare afresh another batch.

If the emulsion is right, it is left to drain in the bucket for eight or nine hours, or from morning to night, then the bucket is removed and placed upon five or six sheets of thick blotting paper, previously soaked in four or five changes of hot water and afterward dried to free it of hypo. The netting at the bottom of the bucket comes directly in contact with the paper, and as soon as a sheet is wet it is removed and replaced with a fresh one. The emulsion is worked over with a silver spoon, so as to bring new surfaces toward the blotters.

After all the water has been absorbed, the emulsion is transferred from the bucket to the gallipot (which in the mean time, has been very well cleaned) and is melted by immersing the pot in a water bath having a temperature of 135° F.; 20 c. c. of alcohol are now added to the emulsion, and as soon as it is melted it should be filtered as shown in Fig. 6, through Canton flannel,

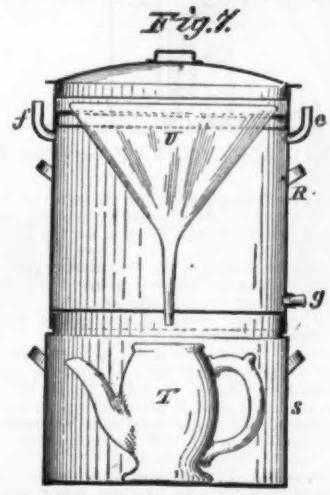
Fig. 6.



THE FILTER.

with the smooth side outward or against the glass of the funnel, and elevated from the surface of the funnel in convolutions or folds by strips of glass, Q, half an inch wide. In Fig. 7 the funnel, U, is set into a funnel-

Fig. 7.



WATER BATH FOR FILTER.

shaped receptacle or seat formed in tin in the interior of the water bath, R, the water in which is at a temperature of 130° F. *e* represents an inlet tube for water, and *f* is an outlet tube for steam; *g* is a cork at the bottom of the bath, by which it can be readily emptied. Below the bath, R, is a metal vessel, S, inclosing an earthern tea-pot, T, which is set just under the tube of the funnel and receives the filtered emulsion. It usually takes about 10 minutes for twenty-two ounces of emulsion to filter through.

THE EMULSION PRESS.

Having now prepared the emulsion for coating, I will describe more in detail the construction of the press, giving the measurements of the same. A, Fig. 3, is a block of hard wood, 8 inches square by 5 inches deep, having a hole, I, 6 inches in diameter, bored through and highly polished. B is a hard wood board half an inch thick by 11 inches square, having a hole 6½ inches in diameter in its center. The piece of wire netting, J, nine inches square, is clamped between A and B, which are fastened together by several screws. Fig. 4 shows a plan view and also the position of the screws. C is a wooden piston, 5¾ inches in diameter and one inch thick, slightly curved on its lower face to correspond with wire, J, and on its upper face is a metal plate, 2 inches in diameter. Secured on each side of the block, A, are two metal uprights, D, having a shoulder at the top, on which rests the cross bar, E, which is held in place by suitable screw nuts on the extremities of the uprights, D, as shown. The screw shaft, F, passes through the nut in the cross bar, E, and as it is rotated to the right, the piston, C, is forced downward.

In operating the press, the small nuts holding the cross bar, E, in place are unscrewed, then the bar and screw are lifted out and also the piston, C. The jelly emulsion is then put in the well, I, the piston, C, placed on top of it, and after that the screw shaft, F, and cross bar, E. As the piston, C, is forced down by the screw shaft, the emulsion is easily and quickly squeezed through the wire cloth.

COATING THE PLATES.

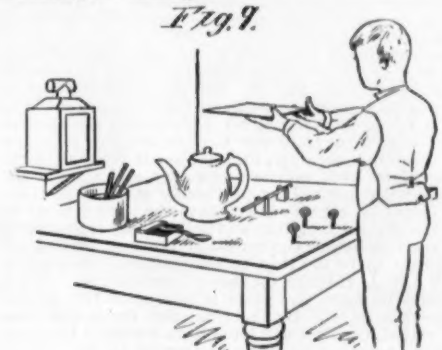
The plates, prior to coating with the filtered emulsion, are coated with a substratum of:

Filtered water....................	30 oz.
Silicate of potash....................	75 minims.

The substratum is applied as follows: After the plates are carefully cleaned, they are placed edgewise in a vessel of water, being completely covered by the same. One plate is lifted out at a time, drained a few seconds, and then has poured over it two drachms of the substratum solution, so that the entire surface of the plate will be covered. The plate is again drained a few seconds and treated to a second flowing of the substratum, is again slightly drained, and then set in and dried in the drying box, Fig. 13, which usually takes an hour.

While the emulsion is filtering into the earthern teapot all the plates are warmed at one time (and they will retain the heat until coated) in the oven of a stove in the kitchen or over a temporary heater. A marble or slate slab, accurately leveled, is provided, of sufficient size to hold ten 6½×8½ plates at a time. The marble top of a wash stand answers the purpose well. The floor of the dark-room is carefully sprinkled, to avoid floating dust during the coating.

Fig. 9.



POSITION OF COATING TOOLS.

Fig. 9 shows the table and utensils used in coating; upon a bracket is the ruby lantern, just below it is a vessel of hot water, in which are immersed glass rods, in front of this is a small box with a strip of wood over the back for holding the silver spoon level, beside the box is the earthern teapot, next to that are two V shaped wood supports for holding the glass coating rods, and near the end of the table are three screw eyes, rising about an inch above the surface. These are sufficiently separated apart to give a good support to the plate, and must be varied to suit the size of the latter. Fig. 10 shows their relative position. The plate,

Fig. 10.

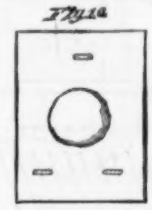
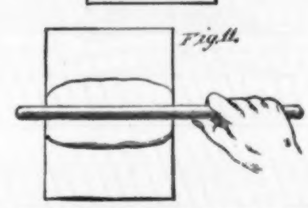


Fig. 11.



SPREADING THE EMULSION.

previously coated with substratum, is now put on the screw eyes and leveled by turning them to the right or left.

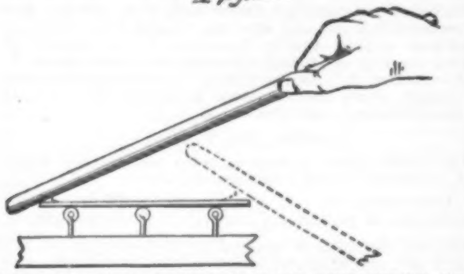
In coating, I use two glass rods and a silver spoon, the latter to measure with. These I keep in the vessel of hot water, under the lamp, Fig. 9, when not in use, that they may be clean and warm. Before using they must be wiped dry with a clean cloth. For coating a 6½×8½ plate, I use a silver spoon of a size sufficient to hold 4¼ drachms of emulsion; for a 5×8 plate, 3 drachms.

To coat the plate, the stone ware teapot is held in the right hand and the silver spoon in the left; the emulsion is then poured into the spoon until the latter is full, then the teapot is set upon the table. A glass rod about ¼ an inch in diameter is next taken with the right hand, the emulsion in the spoon is then poured upon the center of the plate in a pool with the left hand (see Fig. 10). The empty spoon is set in the rack box, Fig. 9. With the glass rod placed square across the warm plate, as in Fig. 11, the emulsion is gradually spread out, first by moving the rod to the right, then the left, which carries it to the edge of the plate. Then the rod is slowly drawn toward one end

of the plate and then brought back to the center, thence to the opposite end, passing through that portion of the emulsion not yet spread.

In case the emulsion has not been brought quite up to the edges of the plate, it can be made to do so, by raising one end of the rod and drawing it along the edges, as shown in Fig. 12. The emulsion will follow

Fig. 12.



DRAWING THE EMULSION TO THE EDGE OF THE PLATE.

the rod, the latter being drawn along from corner to corner.

By drawing the rod lengthwise to the opposite edge of the plate, and lowering it as shown in the dotted line, the emulsion may be evenly coated along that edge.

In coating, the glass rod should not touch the plate, nor be too high. Only by practice can one judge the proper distance. Bubbles can be removed by placing the end of the rod on them, and they will adhere to it; but one bubble must be removed at a time, and after each removal the rod should be cleaned, or the bubble will be replaced.

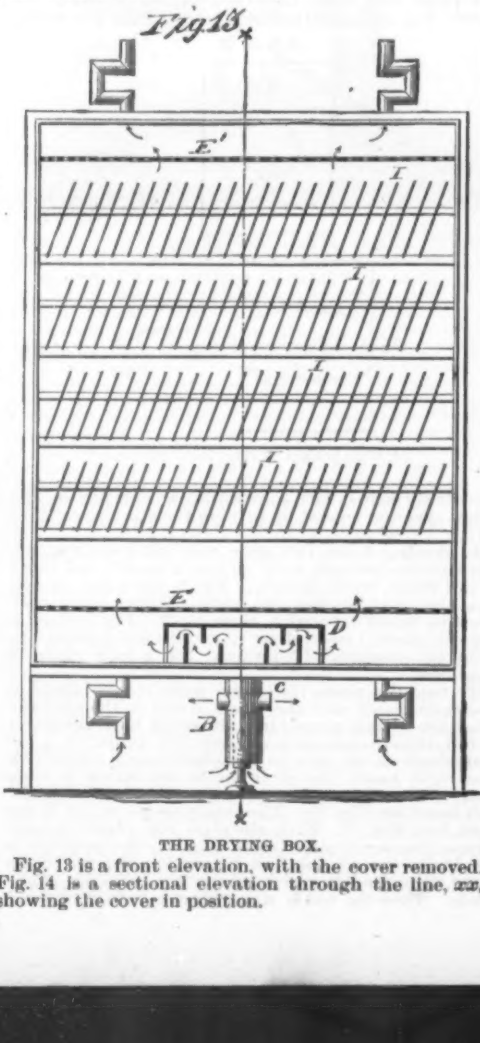
Bubbles are caused by having the vessel holding the emulsion too far below the mouth of the filtering funnel; as the emulsion drops, it forms a bubble. No attempt must be made to remove a bubble after the emulsion on the plate has set.

After coating as described, the plate is removed from the screw eye supports and held as level as possible with the hands (see Fig. 9), the thumbs being up, so they will not come in contact with emulsion. The plate is raised to be nearly on a level with the eyes, so the reflected light from the lantern will strike on top of it. Observe it carefully for bubbles. If these are seen, set the plate back on the screw eyes, and remove the bubbles with the rod, as previously stated. If there are no bubbles, elevate the plate so the light will strike it on the glass side or below (Fig. 9). The transmitted light shows whether the emulsion is evenly coated. If it appears to be too thin in one portion, the plate is gently tilted, till the emulsion runs over it. When it appears uniform, the plate is put upon the leveled marble slab to set. By the time the tenth plate has been coated, the first will have been found to have set. These are removed and set up edgewise in the drying box. By the time the first six plates have been placed in the drying box, the last lot will be set and ready to remove. All the apparatus is cleaned with hot water after using (the filtering cloth also), and rinsed until the washing water shows no signs of milkiness.

After the tenth plate has been coated the silver spoon and coating rod are put into the hot water vessel, Fig. 9, which cleans them.

In addition to the guide previously given for the amount of emulsion to be put upon the plate, it is advised that enough be spread to make a wet film so opaque that the flame of a ruby lamp cannot be seen through it. As a general rule, a film is more transparent when wet than when dry.

Fig. 13



THE DRYING BOX.

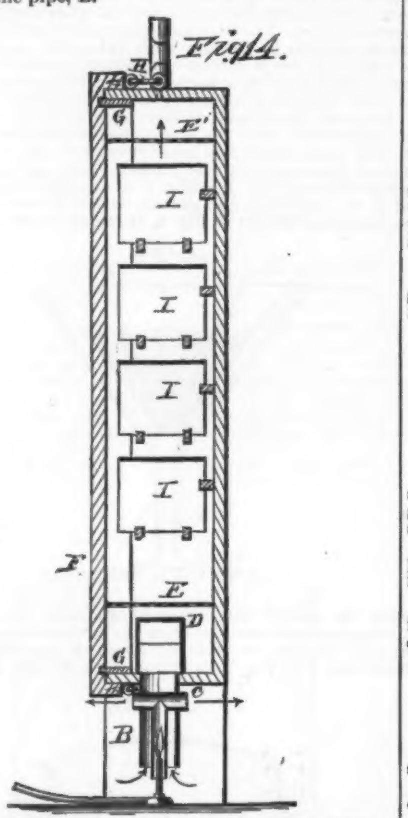
Fig. 13 is a front elevation, with the cover removed. Fig. 14 is a sectional elevation through the line, *xx*, showing the cover in position.

Fig. 15 represents a detail view of the drying racks.

The box may be made either of 1½ inch thick pine boards, or of metal. A size capable of holding eight dozen plates measures in its interior 37 inches wide, 48 inches high, by 10 in. in depth. The box is supported on legs a suitable distance from the floor or table, but, if desired, may also be attached to a side wall. Secured to the bottom of the box is a Russia iron pipe, B (Figs. 13 and 14), 4 inches in diameter by 12 inches long. Inclosed within the pipe is an iron gas pipe, *c*, 2 inches in diameter, supported therein by a T arm, which projects through each side of the Russia iron pipe, as shown, three inches below the bottom of the box. Within the pipe, *c*, is put the gas or kerosene lamp. The heat from the latter maintains the gas pipe at a uniform temperature and escapes through each arm, as indicated by the arrows. By this means no light can enter the box from the lamp. The lamp is burned very low. The temperature of the air entering the box should not exceed 90 degrees Fahrenheit, and the pipe, B, should never get warmer than 110 degrees Fahrenheit. The cool air is drawn in at the bottom of the pipe, B, between it and the hot pipe, *c*, thence ascending to the distributing box, D (Figs. 13, 14), provided with suitable deflectors, passes out from the box up through the perforated air filtering partition, E (consisting of an inch board drilled with half inch holes), and is thereby evenly distributed throughout the interior of the box.

Eight inches below the top of the box is a second perforated partition, E', through which the air filters and finally escapes by the two four inch in diameter bent exit Russia iron pipes as shown. At the bottom of the box are two similar inlet air pipes 3 inches in diameter, arranged equidistant between the outer edge and the pipe, B.

Fig. 14.



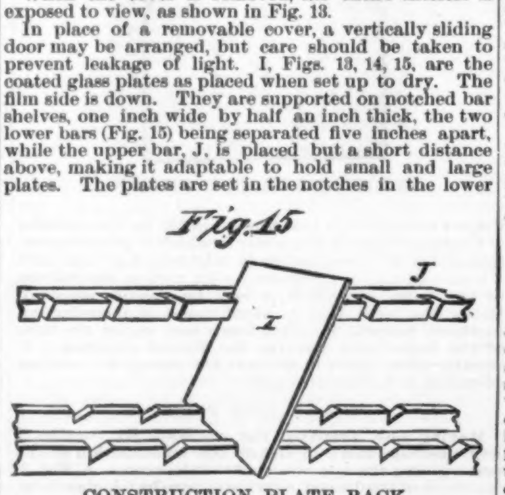
SECTIONAL ELEVATION OF DRYING BOX.

In Fig. 14, F represents the door or cover of the box, which is rabbeted to fit over a projecting strip, G, secured to the inside edge of the box for the purpose of making a light-tight joint. The cover, F, after being pushed into place, overlaps by two inches the outside edges of the box, and is secured thereto by the latch hooks and eyes, H, at the top and bottom.

When the cover is removed, the entire interior is exposed to view, as shown in Fig. 13.

In place of a removable cover, a vertically sliding door may be arranged, but care should be taken to prevent leakage of light. I, Figs. 13, 14, 15, are the coated glass plates as placed when set up to dry. The film side is down. They are supported on notched bar shelves, one inch wide by half an inch thick, the two lower bars (Fig. 15) being separated five inches apart, while the upper bar, J, is placed but a short distance above, making it adaptable to hold small and large plates. The plates are set in the notches in the lower

Fig. 15



CONSTRUCTION PLATE RACK.

bars, and then slide edgewise in the notch in bar, J. With this box, plates may be thoroughly dried in from twenty to thirty hours. The room must be kept clean and the floor dampened to avoid the danger of dust settling on the damp films. After the plates are dried, they should be removed, dusted with a camel's hair brush, and carefully packed, face to face, or with mats between, in boxes, and the latter kept on edge. When it is desired to remove the cover, F, Fig. 14, which should not be done until eighteen hours after the plates are put in the box, the lamp should be turned out.

FINAL SUGGESTIONS.

Every article used in making the emulsion must be carefully cleaned after using.

Flasks should be cleaned with shot and tea leaves, as well as the stone bottle. It is difficult to tell when the stone bottle is perfectly clean, hence extraordinary precautions are required. It should first be rinsed out with boiling water, and then treated with shot and tea leaves, and again well rinsed. I have had fog after fog occur in five batches of emulsion, which proved to be due to the fact that the stone bottle was not thoroughly clean.

The rapidity of the emulsion I estimate to be equal to 20 on Wernerke's sensitometer. The ferrous oxalate developer will work well with these plates, also the carbonate of potash and pyro developer. The former is prepared by making saturated solutions in boiling water of sulphate of iron and neutral oxalate of potash. Both solutions, when cool, may be acidified with sulphuric acid. The iron solution needs but three drops of acid to thirty-two ounces of solution. The oxalate is acidified until blue litmus paper turns red.

The normal developer will then consist of:

Saturated solution oxalate potash	3 oz.
do do sulphate iron	½ oz.

In case of under-exposure and slow development, the iron solution can be safely added to the oxalate, which should always be the order of mixing, until the proportions do not exceed one ounce of iron to three ounces of oxalate. To remedy over-exposure, the developer should consist of one drachm of iron to three ounces of oxalate, with one or two drops of the following solution added:

Water	1 oz.
Bromide of potassium	48 grains.

Should the development proceed too rapidly, more bromide should be added, two or three drops at a time. On the other hand, if it is too slow, more of the iron solution should be added, in small quantities at a time, until the desired speed is reached. This developer is particularly recommended for landscapes. For general and drop-shutter work the pyro developer known as

"THE BEACH POTASH DEVELOPER"

gives excellent results and allows considerable latitude in exposure. It is prepared as follows:

No. 1.—Pyro Solution.

Warm distilled or melted ice water	4 oz.
Chem. pure sulphite soda (437 grs. to oz.)	4 "

When cooled to a temperature of 70° Fah., add:

Sulphurous acid	3½ oz.
Resublimed pyrogallol (437 grs.)	1 "

The pyro is best dissolved by pouring the sulphite solution into the pyro bottle and then out into a graduate, repeating the pouring until completely dissolved.

If pure, it will dissolve very rapidly. When completed, the solution should measure nine and a half fluid ounces.

No. 2.—Potash Solution

is prepared with two separate solutions as follows, each ounce of the salt containing 437 grains:

a	Water	4 oz.
	Chem. pure carbonate of potash	3 oz.
b	Warm water	3 oz.
	Chem. pure sulphite soda	2 oz.

a and *b* are now combined, forming one concentrated solution.

Each ounce of No. 1 contains approximately 48 grains of pyro, and each ounce of No. 2, 154 grains of potash.

It will be seen that the potash solution is quite concentrated, so that a small quantity is only necessary for use in development.

A normal developer would be made up as follows:

Water	2 oz.
Pyro solution (No. 1)	1 drachm.
Potash solution (No. 2)	30 minims.

If more density is required, from one to two drachms more of No. 1 may be added. If the development proceeds too slowly, from one to one and a half drachms of the potash solution may be added in small quantities at a time, until the right speed of development is attained. By thus varying the proportions, the developer can be made to suit either an over or an under exposed plate.

The negatives possess a brilliant, clear, bluish gray color.

Having thus described as minutely as possible the various steps in the preparation of an emulsion, also the apparatus used, all of which has been very successful in my hands, I leave the subject with the hope that what I have stated may prove to be of some benefit to others.

TAR PAVEMENT.

T. H. MEEHUEN.

TAR pavement may be made of the ordinary cinder-dirt produced in gas-works, of shingle, or of a mixture of both. The material is burnt in heaps like ballast, and when hot is mixed with hot tar. In practice a small fire of coke is made on the ground, and covered with cinder-dirt or shingle. When this layer is hot another is added, and so on in succession, until a heap large enough has been provided. The tar is now boiled in an iron copper, and taken when hot and mixed with the hot materials from the heap already described, in quantities of two bushels at a time, in about the proportion of one gallon to every bushel of cinder-dirt, and slightly less than a gallon for the gravel. It is turned over and over with the shovel until every part of the material has got a covering of tar. Then the whole is passed through a sieve with ⅝ inch mesh, and part of it through another with ¼ inch mesh, and put in heaps until required. Indeed, it may be kept for months before being laid down. Before the pavement is laid, an edging should be provided, about two inches thick and

projecting two inches above the surface of the ground to be covered, which should be tolerably even.

It is advisable to have the ground next the curb well trodden on and rammed before the pavement is laid, otherwise there will be an unseemly hollow next to the curb. In laying, the rough stuff is put down first and rolled tolerably firm, then the second quality is put on, then the third; and when the whole has been raked level, a little of the finest material is sifted on through a sieve with ½ inch meshes, and a little fine white shingle or Derbyshire spar is sprinkled on the top. The whole must now be well rolled. The best roller is a water ballast roller, which at first is used without ballast, and well wetted to prevent adhesion of the material; and when the pavement is slightly consolidated, the full weight should be applied. For heavy cart traffic the material should be made of shingle, only treated and mixed as above, and well rolled. Both descriptions of pavement are laid best and most easily in warm weather, and should be rolled when the sun has warmed it well. Those parts in angles should be well rammed and trimmed off with a light shovel.—*London Architect.*

THE AFRICAN DWARFS.

AN entirely new illustration of that highly interesting subject, anthropology, is furnished by the dwarfs which were found by Mr. G. M. Farini during his exploration of South Africa, and which are now on exhibition at the Concordia Theater in Berlin. The transportation of these six dwarfs from their native country, near Lake Ngami in the northern part of the Kalahari desert, was accomplished with much difficulty, and even danger to the leader of the expedition.

Farini undertook this journey for the sake of verifying the accounts given by travelers of the dwarfs found in the Kalahari desert. Toward the end of the year 1884, he went to Cape Town and from there to Kimberley, where he purchased ox teams, wagons, provisions, etc., and various articles to be used as presents to the savages. After traveling a considerable distance, a part of the company was sent ahead to reconnoiter, and they returned with several little people, who were armed with bows and poisoned arrows. Friendly overtures, gifts of sugar and coffee, etc., soon won their confidence, and the appearance of the strange white men and their wonderful weapons excited their curiosity, and they were persuaded to undertake the journey to Europe with Farini.

At first sight, these people, the tallest of whom is about 4 ft. 6 in. in height, appear like boys of nine or ten years; their limbs are well formed, their hands and feet are small, and their skin is bronze-colored. The expression of their faces is very restless. Their language consists of inarticulate sounds and combinations of sounds, and they use many gestures. They are very intelligent, and their powers of mimicry and observation are well developed. Schweinfurth and Du Chaillu are the only explorers who had come in contact with this race of men, and the former stated that it was impossible for him to learn their language; but he confessed that this race, to which he gave the name of "Akkas," surpassed all other African races in intelligence, shrewdness, and boldness. They do not live in tribes, but in families, each of which recognizes a chief, who is usually the largest and strongest member of their company. They have no marriage ceremony and no religion of any kind. They have no established dwelling place, and if night overtakes them on the desert, they dig a hole in the ground, throwing the sand up at the sides of their excavation, and thus find all the protection they need. These people display great courage and cunning in hunting wild animals. They crawl over the ground face downward, approaching their victims quite unobserved, and, when sufficiently near, shoot them with poisoned arrows. After an animal has been killed in this manner, they cut out the arrow and the flesh surrounding it, and then cook the rest, of which they eat enormously.

These dwarfs give exhibitions on the stage of the Concordia Theater, illustrating their manner of life. Among other things, they show their method of killing ostriches, which is as follows: A man covers himself with an ostrich skin, and then approaches the wild ostriches, scratching and picking the ground as he moves along. He soon attracts the attention of the birds, and when they come near enough shoots them with his poisoned arrows. The birds which are not wounded are frightened and run away; the disguised hunter imitates their actions and follows them, thus finding opportunity to kill more of their number. Finally, however, they discover his deceit, and hasten away, leaving him far behind.—*Illustrirte Zeitung.*

THE AFRICAN DWARFS.

DRAINING FOR PLANTATIONS.

THE essential difference between drainage for plantations and for agricultural purposes is that for the former open ditches or waterways are used, but for the latter covered pipe or tile drains. The reasons are obvious, as for agricultural purposes, where the soil is continually stirred and horses and implements are employed, an even surface, presenting no obstacles to their passage, is the first consideration. With plantations the case is quite different, as the presence of open drains cannot be objected to on this ground. As this is so, and, on the other hand, if the use of covered drains was attempted, the roots of the trees would most certainly choke them, to say nothing of the increased cost, it will need no further explanation why open drainage is almost always adopted where the site has to be planted with wood.

As to the actual way in which the drainage of land intended for plantations is set about, much will depend on the soil, the situation, and the conformation of the site itself. In fact, so varied is this, that no one set of rules would apply in every particular to two cases. Notwithstanding this, the principle in all instances will be much the same. The annexed diagram represents a piece of inclosed land which, it is assumed, has to be planted with trees, and from this several of the most important points to be observed in freeing plantation sites in general from superfluous water may be drawn.

The outfall is the first thing which demands consideration. In the plan before us, which, it may be well to say, has been prepared from a field which is in the condition indicated, it will be seen that but little difficulty has been experienced in this respect, as it happens that a natural waterway already exists along the entire length of its lower boundary. There the only thing which has to be attended to is to see that this is properly cleared and freed from any obstruction which may be likely to hinder the free flow of the water as it leaves the main drains. In very many cases, however, the outfall is not so readily found or made at so small a cost. Where the site is almost a dead level, it is no unusual thing for it to become necessary to carry a principal drain for a very considerable distance before a sufficient fall can be found into a suitable natural channel. In this, as it has been said, the details are different in almost every undertaking, but the principle is the same, viz., to find a spot at one boundary of the area where the water which collects over the ground may be carried away with as little hindrance as possible.

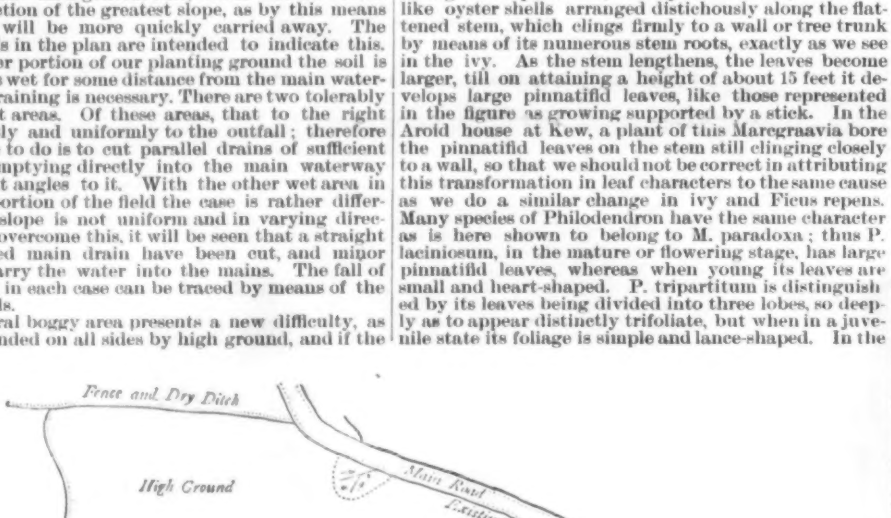
The main drains here, as in agricultural drainage, are those into which smaller drains empty themselves, but for the purpose under review they need not be laid down with such mathematical precision as would be essential with covered mains. The level in each case must of course be observed, but with open drains the preservation of direct lines or particular angles is not so important, provided they are arranged so that they will effect the object for which they are intended. It will be seen that the area shown in the diagram, with the exception of its upper boundary, is already surrounded by water courses. These, however, from want of attention, have become more or less choked and inoperative. To thoroughly cleanse these and put them in working order will be our next business. We take first the existing ditch on the right hand boundary of our plan. This, it will be seen, if followed up from its outfall into our main waterway, passes along this right-hand boundary and receives the water from the ditch which flanks the main road. This latter, it will be observed, does not terminate within our area, but continues underneath the main road, and is consequently one of the outfalls of the drainage of the higher land on the opposite side of the road. So long

as our ditch remains choked, the water which comes from this outfall naturally spreads itself over a portion of the surface of our field, and consequently a wet area is produced as shown. To remedy this, and also to help in reducing the amount of moisture which legitimately belongs to the site of our operations, it is essential that this ditch be thoroughly scoured from its outfall to the point where it crosses the road and leaves the field. At one or two spots along the margin of this ditch, where depressions exist and undue moisture is retained, some short trenches or open drains will be required, as shown. With respect to the old ditch on the opposite side of the field, it will be seen that very little water comes from the upper portion. This should of course be cleansed, but not necessarily to so great a depth as the lower portion, which we shall have to make one of our principal outfalls. This being so, it will be important that this portion be both lowered and widened from its final outfall into the main waterway to the point where it passes through the fence and receives the water from the open main, which we have to construct to tap the bog which lies to the right of and above it. This is one of the wettest spots in the whole area, and will require a good sized drain to effectively carry off the water. A little judgment, too, must be exercised in deciding upon its width at the top, as with a soil of this nature it will be necessary to form the banks with a greater angle to prevent their slipping and blocking the waterway and obstructing the free flow of water. The spot between this and the fence, denominated a wet area, requires to be drained, but its character does not necessitate our going to so great a depth or width as in the case of the bog; so it will be seen that what in agricultural drainage would be termed a sub-main has been led into our main, and the minor drains in their turn into this.

The sub-main does not occur much in the work before us, but where it is used it does not call for further remark, as its business will be readily enough understood from its name. Hitherto we have, with the exception of the drain just spoken of, been engaged with existing watercourses, the levels of which have already been determined, so that much has not been said on this matter. It is, however, so obvious to every one that water must be drawn from a higher to a lower level, that no other reference need be made as to this simple fact. In an area like the one to which attention is now being called, the eye will be a sufficient guide as to the lowest spot, without the aid of instruments, but where this is not so, leveling should be resorted to.

The direction of the drains will require a little thought, as, although they may be theoretically right and serve to draw off the water, the rapidity of the operation will depend to a considerable degree upon their arrangement. As a general rule, drains should be cut in the direction of the greatest slope, as by this means the water will be more quickly carried away. The arrow heads in the plan are intended to indicate this. At the lower portion of our planting ground the soil is more or less wet for some distance from the main waterway, and draining is necessary. There are two tolerably distinct wet areas. Of these areas, that to the right slopes gently and uniformly to the outfall; therefore all we have to do is to cut parallel drains of sufficient capacity, emptying directly into the main waterway and at right angles to it. With the other wet area in the lower portion of the field the case is rather different, as the slope is not uniform and in varying directions. To overcome this, it will be seen that a straight and a curved main drain have been cut, and minor drains to carry the water into the mains. The fall of the ground in each case can be traced by means of the arrow heads.

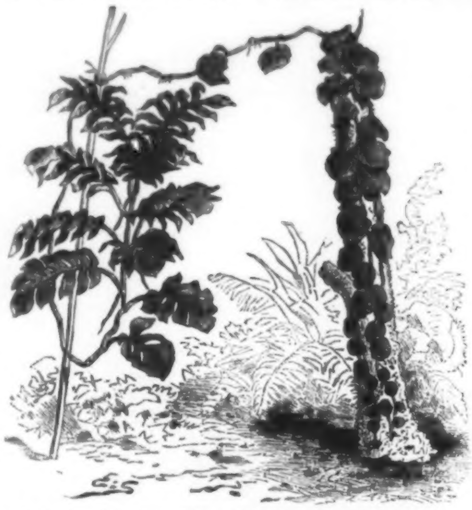
The central boggy area presents a new difficulty, as it is surrounded on all sides by high ground, and if the water from it is to be drained completely away, a main must be cut in the direction of the dotted line and joined to that which drains the lower portion of the field. This, however, would entail some rather heavy excavation, and to obviate it we have assumed that drains are cut through the different parts of this central area in the direction of the lowest ground in it, which would by this means be converted into a small pond. Such a thing in the center of a plantation may not be altogether undesirable, as its edges may be planted with trees suited to the situation. At any rate, the occasional adoption of the plan would help us over a difficulty in our work, and the loss of the small area occupied by it would not be of great moment.—*D. J. Yeo, in The Garden.*



PLAN OF DRAINAGE OF FIELD PREPARATORY TO PLANTING WITH TREES.

MARCGRAAVIA PARADOXA.

THE remarkable Aroid known in gardens under the above name was introduced into England by the late Dr. Seemann, who sent it from Nicaragua about fifteen years ago. In the early stages of its growth it bears some resemblance to the West Indian Marcgraavia umbellata (syn., M. dubia), and to this resemblance is due the widely erratic name under which Seemann's discovery has been distributed. In the *Revue Horticole*, M. Carriere changes the name to Scindapsus anomalus, probably because of its similarity to S. pictus. But the genus Scindapsus is not found anywhere in the New World; nor will the nervation in this so-called



MARCGRAAVIA PARADOXA, SHOWING ITS TWO STAGES OF GROWTH.

Marcgraavia agree with what we find in the true species of Scindapsus. Until the plant flowers, therefore, it had better remain under the name Seemann gave it. A comparison of it with the genus Monstera makes one suspect it belongs to that genus, which is found in tropical America, and whose leaf characters are similar to what we have represented in the annexed figure. Marcgraavia paradoxa, in its juvenile form, has leaves like oyster shells arranged distichously along the flattened stem, which clings firmly to a wall or tree trunk by means of its numerous stem roots, exactly as we see in the ivy. As the stem lengthens, the leaves become larger, till on attaining a height of about 15 feet it develops large pinnatifid leaves, like those represented in the figure as growing supported by a stick. In the Aroid house at Kew, a plant of this Marcgraavia bore the pinnatifid leaves on the stem still clinging closely to a wall, so that we should not be correct in attributing this transformation in leaf characters to the same cause as we do a similar change in ivy and Ficus repens. Many species of Philodendron have the same character as is here shown to belong to M. paradoxa; thus P. laciniosum, in the mature or flowering stage, has large pinnatifid leaves, whereas when young its leaves are small and heart-shaped. P. tripartitum is distinguished by its leaves being divided into three lobes, so deeply as to appear distinctly trifoliate, but when in a juvenile state its foliage is simple and lance-shaped. In the genus Monstera, too, the same dual character is observable, one species, viz., M. dimidiata, being very similar in nervation as well as in general habit to our Marcgraavia. The climbing Anthuriums do not appear to have these two forms of foliage; for on cutting back the above named Philodendrons and Monsteras, the first few leaves on the new lateral shoots thus made to grow were similar to what we find on young plants (*i. e.*, oyster-shell-like), whereas the same operation when performed on the digitate-leaved Anthuriums resulted in the new leaves being precisely similar to the mature form. The Aroid known in gardens as Pothos aurea is another striking instance of the wide difference between the leaves of the young and of the old plants, the former being ovate and about as large as the palm of the hand, while the latter are very large, 18 inches or so long, and deeply pinnatifid. This plant is a native of the Solomon Isles, and is probably a Raphidophora, certainly not a Pothos.

Mr. Darwin has suggested that in many climbing plants there is often striking evidence of Nature's economy in the peculiar habit of growth or leaf characters they reveal; and in the case of these climbing Aroids, it seems not unlikely that the leaves are small, and press closely to the trunk of the tree against which they climb, so as to escape browsing animals or other enemies to their attaining full size and developing flowers. Their stems are so herbaceous and easily broken that if they hung at all loosely they would be almost certain to get snapped.

In Marcgraavia umbellata we have a very attractive form of what we may term dimorphic growth, the branches being somewhat flattened, and by means of roots growing quite close to a damp surface, so that even the oval-shaped leaves cling as though glued down, while in others the branches are rounded, rootless, and bear long, lanceolate-pointed leaves. At Kew there are some very good examples of this strange plant, and on one of these we saw a branch of the lance-leaved form returning again to the small-leaved clinging habit, although it was not near anything to which it could cling. In tree ivy a similar reversion to the climbing form is not uncommon. Perhaps the only exception to this rule of reverting back to the first habit under favorable circumstances is in Ficus repens. As every one knows, this plant under certain conditions develops from a round-leaved, rooted branched, clinging habit to that of a rambling shrub with leaves 4 inches or more long. This is supposed to be the fruiting stage, and is but rarely met with. But the interesting point about this plant is that the large-leaved or fruiting form retains that character wherever it is grown, and is apparently permanent. We have frequently tried to get it to revert back by striking cuttings of it, but have never succeeded.—*W. W., The Garden.*

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